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ABSTRACT

This hearing on the Computer Education Act of 1987, which is intended to encourage schools to develop and strengthen programs for using computers and to assist less well-off schools and students, includes prepared statements by: (1) Katherine Borsecnik, Software Publishers Association; (2) Jay N. Goldberg, ADAPSO, the Computer Software and Services Industry Association; (3) Oliver R. Smoot, Computer and Business Equipment Manufacturers Association; (4) Linda Naimi, Connecticut State Department of Education; (5) Angela Caruso, Newark (New Jersey) School District; (6) Linda G. Roberts, Office of Technology Assessment; (7) Marc S. Tucker, Carnegie Forum on Education and the Economy; (8) Henry Jay Becker, Johns Hopkins University; (9) Thelma Dickerson, Hartford (Connecticut) Board of Education; and (10) Marilyn Monahan, National Education Association. Statements by several students and teachers are also included. (MES)

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COMPUTER EDUCATION ASSISTANCE ACT OF 1987

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HEARING

BEFORE THE

SUBCOMMITTEE ON
EDUCATION, ARTS AND HUMANITIES

OF THE

COMMITTEE ON
LABOR AND HUMAN RESOURCES
UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

FIRST SESSION

ON

S. 838

TO PROVIDE FINANCIAL ASSISTANCE TO THE STATES FOR COMPUTER EDUCATION PROGRAMS, AND FOR OTHER PURPOSES

AUGUST 4, 1987

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COMPUTER EDUCATION ASSISTANCE ACT OF 1987

TUESDAY, AUGUST 4, 1987

U.S. SENATE,
SUBCOMMITTEE ON EDUCATION, ARTS AND HUMANITIES,
COMMITTEE ON LABOR AND HUMAN RESOURCES,
Washington, DC.

The subcommittee met pursuant to notice, at 10:08 a.m., in room SD-430, Dirksen Senate Office Building, Senator Christopher J. Dodd presiding.

Present: Senators Dodd and Harkin.

Also present: Senators Lautenberg and Wirth.

OPENING STATEMENT OF SENATOR DODD

Senator DODD. The Subcommittee on Education, Arts and Humanities will come to order.

Good morning. I would like to welcome our distinguished witnesses and members of the public to the Senate Education Subcommittee hearing on the use of computer-assisted instruction in our Nation's schools.

I can think of no educational issue more timely than the use of advanced technologies to prepare our young people today for the challenges they will face tomorrow. America today stands on the brink of a socioeconomic transformation, unparalleled since the industrial revolution.

We are becoming a nation of words and information; a nation whose ability to develop and utilize new technologies will largely determine our future economic growth, employment opportunities and our relative standing in a highly competitive world economy.

According to the Bureau of Labor Statistics, the technology-dependent service sector will provide nine out of ten new jobs between now and the year 2000. More specifically, BLS estimates that by the end of this century, three out of four jobs will require knowledge of computer technologies as opposed to one in five today.

These are jobs in computer-specific fields like systems analysis and programming which are projected to increase in number by 70 percent in this decade alone. And as advanced technology pervades every sector of our economy, there will be many more jobs in a wide variety of fields for which basic computer literacy will be the bottom line.

The Nation's schools will play a critical role as we prepare the next generation of American workers to meet these new economic

demands and opportunities. But to help our schools meet this challenge, we must shed the national mind-set that looks upon computers as fancy frills in our educational system. They are the pencil and paper of the twenty-first century.

The good news is that many States and school systems have already established computer education programs, programs designed to enhance basic learning and instill the technological awareness needed later in life.

In my home state of Connecticut, for example, the Hartford school system has combined public and private funds to develop a systemwide electronic mail network and a special computer program for gifted and talented children with limited English skills.

In Norwich, Connecticut, and New Haven, Connecticut, public and private dollars have helped to establish computer-based basic skills and literacy programs for at-risk youth and adults.

Nationwide, there are now almost 2 million school-based computers, compared to just 31,000 7 years ago. In 1982, only one in five elementary schools and barely 50 of all high schools had in-house computer systems. By 1985, five out of six elementary schools and virtually all American high schools had computers in place.

The bad news is that many school-based computer programs suffer from lack of funds, inadequate planning and misdirected curricular goals. While virtually all schools now have computers, the average student-to-computer ratio is 40 to 1, and most American students only have one or two hours of computer time each week.

Moreover, statistics indicate that a student's computer access is determined largely by his or her relative wealth and achievement level, and the size, location and ethnic composition of his or her school. Poor and lower-achieving students typically face higher student-to-computer ratios, inadequate equipment, and are more likely to use computers in drill and practice programs as opposed to reasoning and problem-solving.

At our hearing today, we will focus on these and many other issues facing our schools and our Nation as America makes the transition into the Information Age. Specifically, we will consider the need for legislation introduced by Senators Lautenberg and Wirth, which I have co-sponsored, the Computer Education Assistance Act of 1987.

These two Senators will testify here today, as will three experts on the demographics of computer education in the United States. We will also discuss the role of the computer industry with several representatives of software development firms, and we will hear the perspective of teachers and administrators on the needs of computer education programs.

Finally, and perhaps most important, we will see and hear students from Connecticut and New Jersey as they demonstrate the unique and personal benefits of their own computer-assisted learning programs.

Thank you, and I once again welcome you all to the committee. We are delighted to have two of our colleagues from the Senate, the authors of the legislation, Senator Lautenberg of New Jersey, and Senator Wirth of Colorado.

Senator Wirth, of course, was the major force in the House of Representatives on computer technologies and computer-based pro-

grams in our school systems. Senator Lautenberg has been the author of very similar legislation here in the Senate. They are both working together, along with those of us here on the Committee.

Senator Pell would have liked to have chaired this hearing. He is, of course, the Chairman of this Subcommittee, but could not be with us this morning because of other matters. I am delighted to have stepped in for him in this regard, and we are delighted to proceed.

By the way, charts—which we have in abundance here today—and computers are in front of me.

These charts represent very graphically where things have gone. The first one is rather obvious: what has happened in this area since 1981. As I mentioned in my opening statement, almost 100 percent of our school systems now have computers.

On the second chart the colors represent student-to-computer ratios in every State around the country. In the Midwest, Montana, North Dakota, Minnesota, we have the best ratios in the country.

The pinkish color next, Texas, up through the Northern States, Michigan and the like, 31 to 40 students per computer; green, Connecticut, Maine, California, 41 to 50 students per computer. Then the orange colors, in Georgia and Louisiana, 51 to 60 students per computer; Mississippi and the Hawaiian Islands have 60 students per machine, which is far too much. But that gives you some idea of how it spreads out.

With respect to student access to computers the third chart shows we are seeing the numbers going up. You had only a fraction, now it has moved way up on the scale in the last three or four years.

The next one is potential student access and school size. Again, in smaller schools, rural areas, you have a far better ratio in terms of computer access. When you get into the larger schools, it drops down considerably. So there is a disparity that exists there. Again, with minority students that is the disparity that exists in the three different—the elementary, middle, and high school levels.

If anyone would care to look at those charts, we can make those available, as well.

Senator Lautenberg, we will begin with you and then Senator Wirth.

I am going to set a rule here, if I can—I will make an exception with my colleagues because they are my colleagues, but I am going to—because we have got so many witnesses here this morning, say that when our witnesses come up, we're going to limit you to five minutes on prepared statements. We will also accept your prepared documents and we will make them a part of the record.

Senator Lautenberg, we will begin with you.

STATEMENT OF HON. FRANK R. LAUTENBERG, A U.S. SENATOR FROM THE STATE OF NEW JERSEY

Senator LAUTENBERG. Thank you, Mr. Chairman. I appreciate the opportunity to be here with you this morning. I compliment you, not only for chairing this subcommittee hearing today but for

the comments that you made, indicating your deep interest in this problem and the solution thereof.

I want to thank you for holding the hearing on S. 838, the Computer Education Assistance Act, that I introduced, along with my colleague, Senator Tim Wirth, and with the Chairman, and nine others. This bill and this hearing have particular meaning for me.

A little over 4 years ago, I made my first speech on the floor of the Senate. The topic was, the Information Age and its Impact on Fairness and Opportunity in our Society. I spoke about the use of computers in education. I spoke about how important it was that we, as a nation, learn to use and understand computers. I raised my concerns about disparities in the distribution of computers among the schools.

Mr. Chairman, what I said that day is still relevant. As we address the issues of education in an information age, we must address the question of equal opportunity. We continue to debate what is the appropriate Federal role when it comes to education. Well, I believe that a major responsibility is to even out the inequities, to ensure equal opportunity.

We're considering various proposals to ensure an education appropriate to our time. We must see to it that all our children have an equal chance to get the education they need to grow and succeed in America today.

The bill we are discussing today, S. 838, is both about computer education and about equity. It is intended to encourage schools to develop and strengthen programs for using computers and to assist less-well-off schools and their students to catch up to their more affluent neighbors.

Our competitive position in the world, America's competitive position in the world, depends on our ability to innovate, to adapt and to demonstrate technical prowess. We can meet the challenge of the future, but only if we produce, now, well-educated, skilled and creative workers—workers who understand the use of the new information technology. To do that, we need adequate resources to support the best possible education for our children. Computers have to be part of that process.

Computers are tools, as you have mentioned, Mr. Chairman, as pencils or books are tools. But they are much more. Computers can make a difference in the way children think and learn. Teachers have to understand that. Once they do, they can open up a whole new magic world for children.

Mr. Chairman, I've visited with children using computers in Newark, at schools in Newark. When I asked them what they're doing, they don't say they're learning computers; they say they're learning a particular subject—for example math, or they're learning to read.

Businesses understand the potential of computers and they have captured it. Some of our witnesses today will discuss that. And the schools are starting to understand that as well. We are going to see a demonstration of children using computers this morning, and we will hear from educators about what they see as the future.

If schools in Newark, Hartford and around the country are already using computers, why, one may ask, do we need S. 828? Well, what we will see and hear about today is that we're just approach-

ing dawn—a bright dawn, but still, only dawn. We do not yet know what kind of a day it's going to be. We can affect that—we can make it a bright day for computers in education with the programs spelled out in the bill.

The bill would establish a grant program to enable the States to provide funds to schools to buy hardware and software. But at least half of these funds must serve disadvantaged students. To get those funds, schools must plan for the use of computers—no plan, no funds. The bill prescribes the elements of the plans, which would lay out how computers will be incorporated into the curriculum in all subjects.

The bill also authorizes teacher training institutes to be run with grants from the National Science Foundation. And finally, the bill calls for technical assistance and information dissemination. This will help school districts learn what materials are available and to develop model ways to use the computers in schools.

The major elements in the bill are closely tracked by recommendations of the National Governors Association Task Force on Technology, which was part of their 1991 Report on Education. The Task Force talked about the need for formal plans for the use of technology in the curriculum. It discussed the need for teacher training and for the integration of technology in the curriculum. And the report noted the need to increase technology resources and to improve the ratio of hardware to students.

And of particular interest for this committee, the panel called on the Federal Government to ensure that advances in technology play a significant part in restructured educational systems. The restructuring of education must be a State and local government prerogative. But the Federal Government can help to nurture change and to assure that it is equitably distributed. And that is what the bill before us is all about.

Mr. Chairman, there is a mounting body of evidence about how computers are unevenly distributed in the schools. Again, you commented on that in your remarks. The poor lag behind. The evidence mounts that computers are being spread widely across schools, but not deeply.

The average ratio of one computer to every 37 students is insufficient to make a serious impact on education.

And as the evidence mounts, it becomes increasingly clear that we need to do more in computer education, and that the Federal Government has a role to play.

Mr. Chairman, our witnesses—the children most of all—can make the case better than I. I am pleased that children from New Jersey, from Newark, New Jersey, from the Alexander Street School and the Lafayette Street School in Newark are here, and also youngsters from Hartford, Connecticut.

I will close now by saying again, how pleased I am that this hearing is being held, and congratulate the subcommittee and you, Mr. Chairman, for your leadership and concern for the education of our Nation's children.

Thank you.

Senator DODD. Thank you very much, Senator Lautenberg.

Senator Wirth.

STATEMENT OF HON. TIMOTHY WIRTH, A U.S. SENATOR FROM THE STATE OF COLORADO

Senator WIRTH. Thank you, Mr. Chairman.

I just want to, again, commend you and particularly your continuing and very clear concern for the young people, the children of this country. I think that having an advocate who is as effective as you are in the position as chair of this subcommittee is just great for kids all across the country.

Senator DODD. Thank you very much.

Senator WIRTH. In 1980, Mr. Chairman, I had two things happen to me, politically. One, I was elected chairman of a major technology subcommittee in the House and, second, I got a new district in Colorado. In that district was a school system that had, as a requirement for graduation, computer literacy. Kids couldn't graduate from high school in that district unless they were computer literate.

I thought that was a pretty startling requirement. It was new to me. I had not seen anything like that. We're all used to math and English and, hopefully, language requirements. This school district had a requirement for graduation of computer literacy.

We began to look at that, talked with the people in that district and, out of that, began to draw the lessons that resulted in the first legislation which I drafted, on the House side, related to computer literacy. We worked with Senator Lautenberg at that point, introduced companion bills in 1983-1984, and I am delighted to be with him today and sponsoring this particular piece of legislation.

I need not repeat again the very clear consensus, I think, that is growing about the need for computer literacy in our schools, the changing nature of our economy, the rapidly changing nature of the work force, the need to have people who are trained to move in the very flexible fashion that's going to be required of individuals as their careers change.

That is something that you are very familiar with, and the committee is. And certainly, the international situation has placed competitive requirements upon our young people today that are astonishingly large and, again, are changing very rapidly.

The computer is a tool—to use Senator Lautenberg's words, a very important one—to allow individuals, individual kids to grow up and be able to participate in the economy, in the society of the future. That's what we're trying to do. And I would suspect that most members of the Senate and most members, I would hope, of the country would agree with that.

What we've done today is brought forward a piece of legislation that essentially has three specifics to it: First, the issue of access. It is clear that we can't presume to govern, as a democratic society, if we have some people who are affluent and can participate and go to good schools, and other kids who don't have a chance.

If that gap between rich and poor is growing, as it is in the United States; if that gap between rich kids and poor kids is growing; and if that gap between good schools and bad schools is growing, we, as a democratic society, can't presume that we're going to be fair, can't presume that we're going to offer to all children the opportunities that this country should be all about.

So Item Number 1, specific Number 1 in this bill, are provisions designed to do what we can to help to equalize that gap. We've been trying to do that for a long, long time in this country. Some have suggested that we ought to give that up, that we don't have a role, that the Federal Government shouldn't be involved in it.

I happen to think just the opposite. I think that we have an obligation to continue to push and to try to close that gap, and not just accept that gap.

The second specific piece of this legislation relates to the question of what works and the question of computer proliferation. In part, this is built upon the experience that we had in the Title One Program, now the Chapter One Program of the Elementary and Secondary Education Act.

Remember, in the 1960's, there was an enormous fascination with educational technology. And we went out and purchased a whole variety of teaching machines, audio-visual aids and a whole variety of things that ended up, too often, in store rooms, unused and not involved with the curricula; also, tremendous overlap of things that weren't compatible one with another and no assessment as to what worked and what didn't work.

We'd like to build upon that experience and not repeat that experience and, thus, a second title of the legislation focuses on the evaluation of what works and focuses on the great need to avoid proliferation of a vast number of different kinds of technologies in school districts that can be positively bewildering.

And the third part of the legislation—and I will close with this, Mr. Chairman—relates to teacher training. There are a number of people in this country who continue to say the school system in schools of education and professional training programs don't know what they're doing, we don't know how to do it, and so on. Well, that's flat wrong.

One of the things that we did very, very well in the late fifties through the 1960's, into the 1970's, were some very innovative, effective and carefully designed programs for training teachers in the new math, the new physics, biology, all the sciences, languages and so on. We learned an enormous amount about training and integrating teachers in the new curricula, so it became effective.

We can repeat that history in the area of computer education—and we're going to have to do it. The statistics are pretty sad about the capacity that teachers have now in the school system. Not their fault—they've been there and they weren't computer-literate going in. They're not as good as they ought to be.

What we want to do is to create a new set of summer-training institutes and other ways in which we can integrate teachers and teacher training into the school curriculum. Again, one of those items that we know how to do—we did it very well in the sixties and early seventies—let's build upon that experience.

So, there are three elements in this legislation, Mr. Chairman. First, the issue of access and equal opportunity; second, the issue of what works; and third, the issue of teacher training. We must make sure that all kids have the opportunity they should have to have the tools to participate in the economy and the society of the future.

Again, I thank you very much for including me this morning, and for your consideration of what I believe is a very important piece of legislation. We look forward to working with you and the members of the Committee and your staff, and hope we can move this right along.

Thank you very much, Mr. Chairman.

Senator DODD. Thank you. Your knowledge of this issue, as Chairman of that House Subcommittee on Telecommunications, is very important. I think an awful lot of people associate your work strictly in the telecommunications field and do not appreciate the fact that you really started years ago on this particular issue.

Now, the fact that we have you in the Senate, along with Senator Lautenberg who has had a career in his other life in this industry in its infancy, is very significant.

And one of the great luxuries we have in the Senate is having people who bring to this body that kind of experience acquired in private life, as well as the expertise which you acquired as a member of the House, because of something that occurred in your district.

So we are fortunate, indeed, to have both of you taking the lead on this issue.

Senator WIRTH. Mr. Chairman, if I might add, as well, in a previous incarnation I also ran the old Title One, now Chapter One, Program down at the old Office of Education.

Senator DODD. So you saw what all the States did.

Senator WIRTH. I lived with the frustrations of that, and I hope that, you know, we learn the good lessons and the bad from that, and that we can put those to work.

We did learn an awful lot. We did a lot for kids in that program, and have continued to do so, just as we have in the Head Start Program.

Again, I would just echo what I said earlier, your commitment and continuing to carry the torch is so enormously helpful, and I just want to personally thank you again.

Senator DODD. Thank you very much.

I am going to invite both of you to join me up here, if you would like, as we hear from our first panel of witnesses. Perhaps you would like to engage in some of the questioning and so forth of some of these people. I know you both have busy schedules, and to the extent that you can stay, you are more than welcome to.

Senator LAUTENBERG. I will join you, Mr. Chairman.

Senator WIRTH. Thank you very much, Mr. Chairman.

Senator DODD. Thank you.

Our first panel is the computer industry representatives, Mr Christopher Cerf who is president of Christopher Cerf Associates; Ms. Katherine Borsecnik—did I pronounce that correctly?

Ms. BORSECNIK. You did.

Senator DODD. I did. Katherine is the project director of the Software Publishers Association here in Washington, DC; Mr. Jay Goldberg, chairman of the board, ADAPSO, the Computer Software and Services Industry Association; and Mr. Oliver Smoot, the acting president of the Computer and Business Equipment Manufacturers Association. We welcome all four of you here this morning.

If you have taken a look at the witness list, you can see that we have five panels of witnesses coming up, most of whom include four or more witnesses. I am going to try and activate these lights here so that you can be put on notice that we will take five minutes apiece for your statements—paraphrase them, if you will. And then, of course, everything that you've prepared will be included as part of the committee transcript. Then Senator Lautenberg and I will have some questions for you.

So when the yellow light goes on, that's a warning that—like the good stop light—red is soon to follow. With that in mind, I will begin with the order in which I have introduced you.

Mr. Cerf, we welcome you here this morning. Being the distinguished son of a distinguished father, I can relate to your presence here. We had such great admiration, great joy from Bennett Cerf over the years. It is a pleasure to have you with us today, and we look forward to your testimony.

STATEMENTS OF CHRISTOPHER CERF, PRESIDENT, CHRISTOPHER CERF ASSOCIATES, INC., NEW YORK, NY; KATHERINE BORSECNIK, PROJECT DIRECTOR, SOFTWARE PUBLISHERS ASSOCIATION, WASHINGTON, DC; JAY N. GOLDBERG, CHAIRMAN OF THE BOARD, ADAPSO, ARLINGTON, VA; OLIVER R. SMOOT, ACTING PRESIDENT, COMPUTER AND BUSINESS EQUIPMENT MANUFACTURERS ASSOCIATION, WASHINGTON, DC

Mr. CERF. Thank you, Senator Dodd. It is a pleasure for me to be here, too.

I've been an early convert, I think, to the potential of computers as a medium to educate, and done a lot of work with them in connection with "Sesame Street" and "The Muppets." In fact, I didn't really start out in computers at all. I came to education more trying to combine humor and entertainment with education.

First, working with "Dr. Seuss" at Random House on Beginner Books, trying to make reading fun and interesting with kids, using the same vocabulary that teachers had always used, but in a new entertaining way. And "Sesame Street", with which I was involved very early and helped set up all their multimedia, books, records, et cetera, again, was an experiment in trying to get maximum entertainment into education so that we could motivate kids better.

Joan Cooney, who started "Sesame Street", certainly realized that the show had to compete with whatever else was on television or people would change the channel, wouldn't watch it. And that has been—a lot of my work in education has been centered around that idea.

As I mentioned, "Dr. Seuss" and "Sesame Street" both realized that we could build more entertainment in it than had, but we had several limitations by the media. We were limited by the media we work in.

Imagine trying to teach letter sounds in a book when you don't have any sound to work with, for example; or imagine trying to teach a verb when you can only draw pictures of nouns. A child looks at a picture of a horse running, you may mean that to illustrate the word "run," but it ends up being a picture of a horse, no matter what you do.

Well, computers immediately excited me because they eliminate a lot of those limitations because we have the possibility there of combining print, graphics, animation, sound, video and, most important of all, interactivity, which is something that none of these other media offer.

So as someone who wants to entertain and teach at the same time, you can just be overwhelmed by the potential here. And if you specially add a couple of other factors about computers, I think you will see even more excitement possible, as this is an education medium—the idea that computers are nonjudgmental.

I would much rather lose a game of chess, for example, to a computer than to a friend who I'm competing with. Kids can definitely work quietly and without embarrassment with a computer. Furthermore, computers as a medium in themselves are fun. In fact, my first entry into the industry came because we wanted to use the appeal of video games to teach, not just to entertain.

But all these things are really not enough, which is the quick point I would like to make in this testimony this morning. That if we just use drill and practice on the machine, we're just translating a workbook, and we need to do better than that. We need to open up the power of computers to let kids explore, at their own speed and with real excitement and an opportunity to learn more than, certainly, a workbook could have taught them anyway.

And to do that, I think we need to do several things. We first have to realize the reality of the classroom. As you have been saying already, there is not a computer at every desk. It would be great if there could be, but there isn't. So we have to develop software that recognizes the realities of maybe one computer per classroom, or two, and some brief access to the labs.

I'm glad to see that more computer labs are opening. That does give kids at least limited access to their own machine. But I think we need to develop more programs that allow teachers to use kind of an audience participation kind of thing, with maybe a large screen with the one or two computers that are available.

We certainly need a lot more research and feedback to software developers, like myself. We need to know more about what's really happening in classrooms, and we need more study in order to do that.

I think Senator Wirth mentioned training. That is a vital fact. As he said, many computers are not being used after their purchase because teachers are not aware of the software that's available, and they don't really feel comfortable with the machines. And if they don't feel comfortable, they're likely not to use them, or to try to avoid using them. So I think we need more resources for teacher training.

Another factor I think that's important is that we need to see that computers are more than teaching programming, that we need to do more than that. As I've said, they're a good medium for teaching other things, not just math and science, but also reading and language arts. A lot of our work with "Sesame Street" and "The Muppets" have been directed in that direction.

But also, I think we need to teach applications, not just programming. By that, I mean that we don't really need to know how a TV set processes signals out of the air in order to use it. The same

thing—we don't need to know how to program in order to use a computer.

But kids are going to have to learn word processing and spreadsheet analysis and data base management if they're going to be able to compete in the job market in the future. That seems a good possibility for an alliance between business and education because, certainly, American businesses are going to need that kind of training in their students.

That, basically, sums up—a lot more that I could say, Senator, but at least it's a beginning. Again, I would like to express my delight at being asked to be here, and hope that I can be helpful.

Senator DODD. We appreciate that testimony, and we have seen the application of it along the way. Your hands-on experience means a lot. Obviously, the shows you've mentioned are ones that almost a generation of children have grown up with in the country, and I wish we had more of them.

Ms. Borsecnik, am I still pronouncing that correctly?

Ms. BORSECNIK. That's fine. No one gets it right the first time.

Senator DODD. We welcome you.

Ms. BORSECNIK. Good morning, Mr. Chairman; good morning, Senator Lautenberg.

My name is Katherine Borsecnik. I'm project director of the Software Publishers Association, which is the principal trade association of the microcomputer software industry.

We have 230 members and of our members who publish software, approximately a third are publishers of microcomputer educational software.

I am also project director of Computer Learning Month, a national cooperative effort to promote the use of computers in education and to disseminate information to parents, teachers and students across the country about computer learning. Senator Lautenberg was instrumental in obtaining publicity for that event and generating much of the enthusiasm that has occurred.

Previously, I worked as an educational software designer for an educational publishing company.

Members of the Software Publishers Association support the Computer Education Assistance Act of 1987. Why computer learning? We've talked a lot about computers as educational tools. Computers are not replacements for teachers; rather, they're very creative and flexible tools.

I'd like to give a few examples of why we keep referring to computers as tools. First of all, as Senator Dodd already mentioned, computers are patient tutors of basic skills. They provide a one-on-one environment, which is not always possible in today's crowded classrooms. They also provide immediate feedback, an important ingredient of learning.

Another example of why computers are successful learning tools is that they can provide an environment for simulations. For example, a student in a science class is given the opportunity to perform a simulated experiment that may be otherwise too costly or too dangerous for him or her to perform.

Another example of the computer as a flexible tool is that computers provide a creative and nonjudgmental environment for the novice composer, musician, artist.

Finally, computers reduce the fear of failure. Word processing, I think, is a good example of this. Students love to write with word processing; the reason is that mistakes are extremely easy to correct. The computer allows them to get their thoughts down, then go back and edit, an unimpeded writing environment.

As Mr. Cerf already said, the computer is a nonjudgmental environmental, and that is very positive for a child's confidence. Finally, the primary reason computers are good learning tools is that they're very engaging. Children enjoy using them, they are motivational, and they're just fun to use.

Next, I'd like to address three critical aspects of the legislation. The first is teacher training and dissemination of information. We believe this a very critical aspect of the legislation, and Computer Learning Month provides a good example of that.

As I mentioned, computer learning month is a national effort. We're planning a large number of activities to promote dissemination of information about computers in education in October of 1987. Since June, we have publicized the fact that we have information available to teachers, parents and students around the country, and have been inundated with about 5,000 requests for information—requests from teachers for information about how to integrate computers into the classroom, how to get parents involved, how to keep children motivated.

The second aspect of the legislation we believe is important is local flexibility. The way the bill is crafted, it allows assessment by local districts, of their resources, their goals and their priorities. It allows them to tailor-make computer programs to address those concerns.

Finally, the last aspect of the bill that we think is important is the provision for disadvantaged students. Although many economically disadvantaged students do have access to computers in the classroom, they obviously do not have access to computers at home, as many of their peers might. Therefore, they do not have the added advantage of reinforcement and the school-home connection a computer can provide.

In summary, public education in this country has always been responsible for helping students acquire the skills they need to contribute to the world in which they will graduate.

Right now, the average student spends less than a half hour per week learning with a computer. Yet 70 percent of today's jobs require some computer familiarity, and that figure is likely to rise in ensuing years.

Today's students need the Computer Education Assistance Act to help them prepare for tomorrow. We urge the support of this committee for S. 838, and we urge the approval of the full Senate. We appreciate your attention to the important subject of computer learning.

[The prepared statement of Ms. Borsecnik follows:]

SPA

Software Publishers Association

Statement of Katherine Borsecnik
Software Publishers Association

Hearing of Senate Subcommittee on Education, Arts, and Humanities
S. 838, Computer Education Assistance Act

August 4, 1987

Mr. Chairman: I am Katherine Borsecnik, Project Director of the Software Publishers Association, a former educational software designer, and Director of a national cooperative effort by computer software publishers and educators, called Computer Learning Month.

On behalf of the 230 members of the SPA, 90 of which are involved in producing innovative computer software for educational use, I appreciate the attention you are paying to the important educational issue of computer learning.

The Software Publishers Association and our members strongly support S. 838, intended to provide financial assistance to states for dissemination of technical information, acquisition of computer hardware and software, and teacher training.

As the authors and co-sponsors of the legislation have said in their own statements, computers are not substitutes for teachers; rather, computers are learning tools. A computer, combined with innovative software, is a flexible tool. It can patiently tutor a child in spelling. It can provide an nonjudgemental creative environment for a novice artist or musician. It can simulate a science experiment otherwise too costly or dangerous for a child to perform.

The flexibility of computers as teaching tools is not their only advantage. Another is that they provide immediate feedback to students. Also, computers create a one-on-one learning environment, which is not always possible in today's classrooms. Computers offer motivational rewards in the form of graphics, music, or learning games. The machines also are nonjudgemental, reducing a child's fear of failure. Frustration is minimized, since mistakes can be easily corrected with a computer. Used with groups, computers initiate shared learning and teamwork. Finally, computers are engaging -- students clearly like working with them.

The sponsors of this legislation, as expressed in their statement of purpose, recognize another critical reason for increased computer education: the reliance of every industry in this country upon computers in the routine functioning of their businesses. Preparation of today's student's for tomorrow's world has long been a responsibility of public education, and familiarity with the computer technology that is an integral aspect of the working world today is necessary for all students.

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Most school systems have begun the process of obtaining computer resources for their students and integrating computer-assisted methods into the curriculum. By 1990, there will be over 3 million computers in America's classrooms. At the same time, there wil be 43 million students. Student access time to computers is still very limited, however. During the 1986-'87 school year, the average child spent less than a half hour per week at the computer. A confounding problem is that many teachers do not have the software resources or the training to optimally utilize the computers they do have. S. 838 will help teachers and administrators better understand how to utilize computer resources in the classroom.

The SPA would like to focus on three important tenets of the legislation:

(1) A key to S. 838 is local flexibility. S. 838 allows state and local systems the freedom to assess their individualized school system and make localized decisions about how best to utilize their resources and tailor programs to their students' unique needs.

(2) Another important provision of the legislation is the the extension of opportunities for disadvantaged students. These are the same students who are least likely to have access to computers at home. S. 838 attempts to ensure that disadvantaged students are guaranteed exposure to computer learning.

(3) A third major tenet of this legislation is an emphasis on teacher training. The Software Publishers Association believes that computer software prepared for educational needs is of high quality and constantly improving. However, computers aren't teachers, and effective integration of software into the curriculum can only be accomplished with the talents of educators.

The Computer Learning Month project I referred to earlier provides an example of the need for such training. The goals of that project are similiar to those of the Computer Education Assistance Act — to help parents and teachers understand and utilize computers for learning. Since the project's inception early this year, the Computer Learning Month committee has been inundated with requests from more than 7,000 educators to help them better understand how computer-assisted instruction can fulfill the needs of their students. In working on this special project, we have seen that there is a demand for both teacher training and dissemination of information on the availability of instructional materials, both of which are provided for in S. 838.

We'd like to take this opportunity to commend the author of this legislation, Senator Lautenberg, for his leadership in winning passage of another measure dealing with computer learning — S.J. Resolution 103. This resolution designates October 1987 as Computer Learning Month. We hope it encourages local communities to take advantage of the materials that will be available to them in October.

In summary, the Software Publishers Association commends the authors of this legislation for their initiative in introducing the Computer Education Assistance Act. It will help schools acquire essential computer hardware and software resources. Additionally, the act will facilitate integration of computer technology equitably through the dissemination of information to all schools, with a special focus on disadvantaged students. Finally, the legislation provides important teacher training to ensure that the technology is utilized as part of an educationally sound curriculum. We urge the support of this committee and the full Senate for its passage.

Senator LAUTENBERG [presiding]. Thank you very much.

The chairman's temporary absence has nothing to do with the composition of the record nor the interest of the subcommittee. I will continue in the capacity of acting chairman.

We thank you very much for the testimony so far. We will get back to you with a couple of questions.

I would now like to call on Mr. Goldberg.

Mr. Goldberg, your organization is called ADAPSO—for the benefit of those watching, I used to be the president of this organization, going back a number of years ago in my former life. The year was somewhere around 1970, I guess.

Jay, we are pleased to have you here. I look forward to your testimony. You, too, unfortunately, despite our friendship and our involvement with ADAPSO, will be subject to the same time rules as the other witnesses.

Mr. GOLDBERG. Thank you. I'll try to read this quickly.

Senator LAUTENBERG. Jay, we invite you to give your testimony in summary form.

Mr. GOLDBERG. Thank you.

My name is Jay Goldberg. I am chairman and chief executive officer of Money Management Systems. I am pleased to testify today in my capacity as chairman of the board of ADAPSO, the Computer Software and Services Industry Association.

It is most appropriate that ADAPSO appear in support of the Computer Education Assistance Act, since our 950 member firms are on the leading edge of computer software technology. We are greatly dependent on the continuing availability of highly skilled computer professionals in order to maintain the United States worldwide leadership in this important area. ADAPSO is especially pleased to be able to support this legislation introduced by our distinguished former chairman, the Honorable Frank Lautenberg.

The development of computer hardware and software technology has given rise to perhaps the most dynamic of U.S. industries. The computer software and services industry provides the public with an ever increasing variety of computer software and services.

Our member firms are all united by our pressing need for well-trained employees. We already face a substantial shortage of qualified personnel and without computer education, starting at an early age, this shortfall will only be magnified. Because this is such a serious concern for the computer software and services industry, I would like to focus my remarks on our future employment needs and how the Computer Education Assistance Act could be instrumental in helping to address this problem.

In shaping the tools of tomorrow's workers, we must take into account where the jobs of the future will be. Elementary and secondary school students of the past were taught how to use slide rules, the new math and the electronic calculator. Our educational systems responded to each of these new concepts and incorporated them into their curricula. Students exposed to these new tools in their formative years later carried them over into their careers. During the 1980's, individuals have at this disposal one of the most powerful productivity tools ever invented: the computer.

The computer was introduced to the academic and business worlds in the late 1950's. As advances continue in computer hard-

ware and software technology, this tool has become increasingly a part of the average worker's daily routine. The advent of the personal computer in the Seventies has made computer power even more accessible to virtually every student and employee.

But some students have been denied the opportunity to use this powerful learning tool. One of the goals of the Computer Education Assistance Act is to prepare all students for the future by assuring their access to information technology in the classroom.

The growth of service industries in our economy is due in no small part to advanced computer technology. The service sector is clearly outpacing every other segment of the economy in the creation of new jobs.

According to the Coalition of Service Industries, service-producing industries are projected to account for 9 out of every 10 new jobs between 1984 and 1995. These industries will need a vast pool of computer-literate workers to staff business operations. At present, however, it is questionable whether America will have a work force educated and capable of meeting this burgeoning demand.

Computer usage, however, is not limited to the services industries. Other American industries such as construction, printing and publishing, aircraft and automotive manufacturing, and the petroleum industry are finding that the latest technology, such as computer-aided design and manufacturing, is necessary in order to maintain their competitiveness in the world market. Again, for most workers to secure a position in the manufacturing industry of the future, some familiarity with computer systems will be necessary.

The performance of the average worker in the late eighties and nineties will clearly include some kind of computer-related activity. For an individual not trained in the operation and use of computers, employment opportunities will be considerably limited.

For the high school graduate or college graduate with a knowledge of computer skills, opportunities will be numerous. There can be no better basis for ensuring equal opportunity for all students than providing widespread and readily available computer hardware and software in our Nation's elementary and secondary schools.

The sponsors of the Computer Education Assistance Act recognize that today's student cannot meet tomorrow's challenges without possessing some computer training.

The Information Age has transformed our society. It has changed how we work, the way we communicate, even how we spend our leisure time. The computer has been instrumental in this transformation, becoming a tool to perform the most business functions. It is also a strategic asset in securing a competitive edge for U.S. firms.

We must ensure that all students enter the twenty-first century with a knowledge of how to use twenty-first century technology. The legislation before you today will help guarantee that all students will benefit from the most exciting educational tool ever developed: the computer. ADAPSO urges its speedy enactment.

Senator Lautenberg, I would also like to spend one minute commenting, not as chairman of ADAPSO, but as the father of a 5-year-old and an 11-year-old.

My children are privileged. They have a computer at home and they have a computer in their school—many computers in their school. This school asked me to help them in planning computer literacy and educational programs because I've been in the business for 26 years, and my rate was very low.

I can tell you they face a difficult task, choosing from the myriad of hardware and software offerings, developing plans on how the computer should be used or shouldn't be used, whether it is a tool, whether it's a learning instrument, whether it should or shouldn't replace certain teachers. And I can tell you that an Act like this, a bill like this, providing funding to schools that are sorely lacking in resources, will help them to solve those problems.

[The prepared statement of Mr. Goldberg follows:]

the computer software and services industry association

25 years of leadership

Statement

of

Jay N. Goldberg, Chairman

on Behalf of

ADAPSO, The Computer Software and Services Industry Association

Before the

Senate Subcommitte on Education, Arts, and the Humanities

August 4, 1987

Good morning. My name is Jay Goldberg. I am Chairman and Chief Executive Officer of Money Management Systems with offices in New York and Boston. I am pleased to testify today in my capacity as Chairman of the Board of ADAPSO, the computer software and services industry association. It is most appropriate that ADAPSO appear in support of the Computer Education Assistance Act since our 950 member firms are on the leading edge of computer and software technology. We are greatly dependent on the continuing availability of highly skilled computer professionals in order to maintain the United States worldwide leadership in this important area. ADAPSO is especially pleased to be able to support this legislation introduced by our distinguished former Chairman, the Honorable Frank Lautenberg.

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Statement of Interest and Position

The development of computer hardware and software technology has given rise to perhaps the most dynamic of U.S. industries. The computer software and services industry provides the public with an ever increasing variety of computer software and services including operating systems and business application programs for mainframe, mini-, and microcomputers, professional systems design and contract programming services, integrated hardware/software systems, and remote access data processing services.

Although ADAPSO member firms vary greatly in size, business plans, and geographic locations, we are all united by our pressing need for well trained employees. We already face a substantial shortage of qualified personnel, and without computer education starting at an early age, this shortfall will only be magnified. Because this is such a serious concern for the computer software and services industry, I would like to focus my remarks on our future employment needs and how the Computer Education Assistance Act could be instrumental in helping to address this problem.

Computer Hardware and Software Are Essential Educational Tools

In shaping the tools of tomorrow's workers, we must take into account where the jobs of the future will be. Elementary and secondary school students of the past were taught how to use slide rules, the new math, and the electronic calculator. Our educational systems responded to each of these new concepts and incorporated them into

their curricula. Students exposed to these new tools in their formative years later carried them over into their careers. During the 1980's, individuals have at their disposal one of the most powerful productivity tools ever invented: the computer.

The computer was introduced to the academic and business worlds in the late 1950's. As advances continue in computer hardware and software technology, this tool has become increasingly a part of the average worker's daily routine. The advent of the personal computer in the 1970's has made computer power even more accessible to virtually every student and employee. But some students have been denied the opportunity to use this powerful learning tool. The goal of the Computer Education Assistance Act is to prepare all students for the future -- no matter whether the school district is rural or urban, rich or poor -- by ensuring their access to information technology in the classroom.

Computer Literacy Is Important to the U. S. Economy

We already know that America's economy has become service-oriented. Throughout the rest of the twentieth century and into the twenty-first, job creation in the United States will be strongest in the services sector. Data Resources, Inc. (DRI), a well known economic modeling firm, describes this structural shift in a major report recently released on behalf of ADAPSO. DRI designates the service industries as follows: business services, personal services, wholesale and retail trade, finance and insurance, real estate and communications. Just over 20 years ago, these service industries accounted for 34 percent of U.S. total production. This share has increased steadily over the years, reaching 44 percent by 1985. It is precisely this segment of the economy where the heaviest investment in computer hardware and software takes place. The continued growth of these industries, coupled with advances in technology,

will cause computer usage to increase exponentially. At present, however, it is questionable whether America will have a workforce educated and capable of meeting this burgeoning demand.

Computerization and automation have at times been viewed as stifling employment growth rather than enhancing it. The growth of the service industries, however, is due in no small part to advanced computer technology. The service sector is clearly outpacing every other segment of the economy in the creation of new jobs. Since 1978, employment in the service industries has grown by 13.8 million workers, an average annual increase of 1.9 million workers. By 1985, service workers constituted fully 65 percent of total U.S. employment.

There is every sign that this trend will not only continue, but will accelerate. According to the Coalition of Service Industries, in the first quarter of 1987, the service sector (was) the primary engine of job creation in the U.S. economy. In fact, service-producing industries are projected to account for nine out of ten new jobs between 1984 and 1995. The DRI study ranks our industry -- computer software and services -- first in employment growth for 1985 to 1990. Our firms, as well as the users of software and computer services, will need a vast pool of computer literate workers to staff business operations.

Computer usage, however, is not limited to the services industries. Other American industries such as construction, printing and publishing, aircraft and automotive manufacturing, and the petroleum industry are finding that the latest technology, such as computer-aided design and manufacturing, is necessary in order to

maintain their competitiveness in the international marketplace. Again, for most workers to secure a position in the manufacturing industry of the future, some familiarity with computer systems will be necessary.

Conclusion

The performance of the average worker of the late 1980's and 1990's will clearly include some kind of computer-related activity. For an individual not trained in the operation and use of computers, employment opportunities will be considerably limited. For the high school or college graduate with a knowledge of computer skills, opportunities will be numerous. There can be no better basis for ensuring equal opportunity for all students than providing widespread and readily available computer hardware and software in our nation's elementary and secondary schools. The sponsors of the Computer Education Assistance Act recognize that today's student cannot meet tomorrow's challenges without possessing some computer training.

The Information Age has transformed our society: it has changed how we work, the way we communicate, even how we spend our leisure time. The computer has been intrumental in this transformation, becoming a tool to perform the most basic of business functions. It is a strategic asset in securing a competitive edge for U.S. firms. We must ensure that all students enter the twenty-first century with the knowledge of how to use twenty-first century technology. The legislation before you today will help guarantee that all students will benefit from the most exciting educational tool ever developed: the computer. ADAPSO urges its speedy enactment.

Thank you.

Senator LAUTENBERG. Thank you very much, Mr. Goldberg.

I was particularly struck by your reference to American competitiveness, the number of jobs created in the service sector, and the relationship, of course, to the computer familiarity that's required for us to have the skills and the leadership in the service and in the information era that we must maintain. Thank you very much.

Mr. Smoot.

Mr. SMOOT. Good morning, Senator Lautenberg. It's a great pleasure to be here. It's an interesting position when you're last on a panel on which you agree with everything that's been said.

Since you have my written statement, I'd like to abandon that and to address some specific points that have been raised.

First, I think this industry, of which you were once a part and I'm a part, has probably had the most experience of any in applying, this technology in its own business. And I think the central conclusion that we can draw from that, despite all of the training that the companies in this industry engage in themselves, is that the longer the worker or potential worker has been exposed to the technology as a part of his life, then the better integrated he is throughout his working career, and the more flexibility he will have as the business changes, as technology changes. We all have to adapt. If we have been associated with computer technology from the elementary school level, I believe we will adapt much better.

All three of the opening statements talked about educating everyone. One dimension of that is, of course, that education in computer technology should apply not only to the engineer, but also to the poet. There is a practical and appropriate application across the board.

But this other issue of access and inequality is very important. We support the need for access across the spectrum of all students because, after all, whatever your projections are, whether it's three-quarters of the employees in 1999 or all of the employees in 1999 who will need computer technology or use it in their own lives, that means that when you graduate from high school, you should have that familiarity. You're not going to pick it up later.

It's practical, it's a matter of economic necessity as well as part of being an American citizen.

A third point: international competitiveness. We work with associations in other countries, as Jay does in ADAPSO, and the educational systems in other countries are rapidly turning their attention to the use of computers.

Historically, countries like Japan have placed a heavy emphasis on math and science. Now they're integrating this technology into their educational system. And we certainly, if we're going to improve our competitiveness, can do no less.

The point we like about this bill best is the emphasis on planning and training. We believe that's key. And let me just quote a short passage out of a book entitled "Nations at Risk: The Impact of the Computer Revolution", by Edward Yordin.

He says, in his chapter on computers and children:

> Perhaps the most important factor in determining how computers will be used in the schools is the ability of individual teachers to deal with a new technology which they don't always trust and which frequently terrifies them. I have great respect

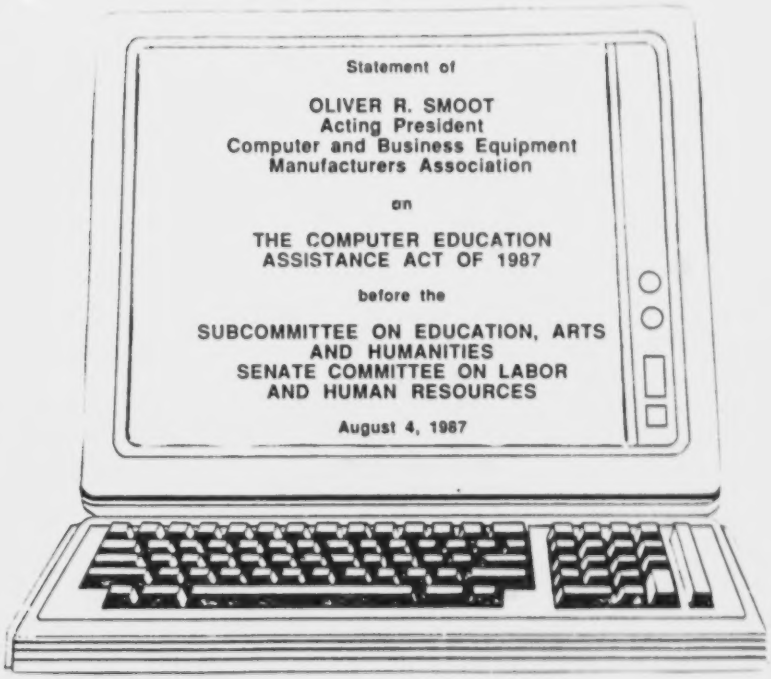
and sympathy for these teachers. Already overworked and underpaid, in most cases, they are now asked for the first time in their lives to deal with something that the children clearly adapt to more quickly than they do.

Parents will generally admit that it's something that they themselves can't accomplish. Just as they have trouble dealing with discipline, sex education, morality and a number of other social skills, computers are one more thing foisted upon the teachers. Some can handle it with some skill, with the same skill, dedication and creativity that they apply to everything else that they do. Some are simply overwhelmed. But the teacher is the gateway to the knowledge that the children are going to go away with, so training and planning are really the key.

Finally, I would like to welcome the very practical emphasis in the bill on computer software and maintenance. I'm sure you know all too well that this technology is not fixed and, in particular, its educational application is, as was already said, just at the sunrise. So we can't buy a set of equipment and expect to use it forever. We can't have the same software programs forever. We need to plan to maintain it and to improve it.

Thank you very much.

[The prepared statement of Mr. Smoot follows:]



Statement of

OLIVER R. SMOOT
Acting President
Computer and Business Equipment
Manufacturers Association

on

THE COMPUTER EDUCATION
ASSISTANCE ACT OF 1987

before the

SUBCOMMITTEE ON EDUCATION, ARTS
AND HUMANITIES
SENATE COMMITTEE ON LABOR
AND HUMAN RESOURCES

August 4, 1987

CBEMA

Computer and Business Equipment Manufacturers Association
311 First Street, N.W. • Washington, D.C. 20001 • 202-737-8888

The Computer and Business Equipment Manufacturers Association (CBEMA) is pleased to add its support to the many voices throughout the United States supporting increased use of computers in our elementary and secondary schools.

CBEMA represents the leading edge of American high technology companies in computers, business equipment and telecommunications. Its members had combined sales of more than $185 billion in 1986, representing 4.3% of our nation's gross national product. They employ more than 1.2 million people in the United States.

Educating the Information Technology Workforce

That large number of employees gives you some idea of the reason for our interest in computer education. To continue as world leaders in information technology, we must have a continuing supply of employees well-versed in all aspects of computer design, manufacture and use.

Years ago, we expected to teach our employees all they needed to know about computers on-the-job. Today, "OJT" continues, but it cannot possibly encompass the basic familiarity with computers with which employees must enter the company. To build our companies rather than let them stagnate, we must find employees who are increasingly conversant with computers. And those employees will be most readily available if we put computers in the

schools, where all socio-economic groups have access and where computer usage can become part of the daily routine.

Educating the Nation's Future Workers

But educating our own future employees is just one reason to support the Lautenberg bill. Of far greater consequence is the education of the entire future workforce of our nation.

We estimate that by the end of this century, just 13 short years away, three out of every four jobs will involve some use of computers, compared with only one job in five today. Companies throughout the nation are turning to computers to increase productivity, improve services, and, thus, better compete with companies around the world, companies in countries making heavy investments in the math and science education of their youth as well as in technology to win markets once reserved for American products. America must either use information technology to increase its international competitiveness or reconcile itself to a declining standard of living and a second-class economic status.

We are not willing to accept such an eventuality. Our companies and companies throughout the American industrial sector are dedicated to a brighter future, a more productive future through the use of technology. But to use it to its fullest, we must have employees who are not only familiar with its potential but who are eager to put it to its best uses. I cannot stress enough that employees who use computers for the first time upon entering the workforce at 18 or 21 will never be as fluent with the

medium, will never be as flexible or as innovative with computers as will their peers who have used computers from their earliest years.

Why This Bill Rather Than Others?

The bill you are now considering, S. 838, has several advantages over earlier bills to promote computer education in our schools.

- First, it stresses the use of computers, the integration of computers through the curriculum rather than special computer classes where students learn the technology. Relatively few students will grow up to work on technology--to develop new machines, to write new software. But the vast majority will grow up to work with technology. It's far more important for a student to learn how to retrieve and store information of all types with a computer than it is to learn how to program in COBOL.

- Second, the bill emphasizes planning for use by school districts. Sadly, in the past, we've seen well-intentioned computer acquisitions end up as dust-gathering machines in a corner because there was no plan for training, no plan for maintenance and security, no plan for integration of the equipment into the curriculum. By requiring extensive planning, this bill ensures that students will use the equipment, not just look at it.

- Third, the bill assures maximum use of computers by making them available to parents, students and teachers after school and on

vacation, for instructional or educational purposes. This availability will give many sectors of the community access to computer knowledge, knowledge they can then take directly with them into the workplace. As the National Academy of Sciences recently pointed out in their study of technology and employment, there is a grave danger that America will fall behind other countries economically if it does not rapidly disseminate information technology in today's workplace. The after-school availability will help with that immediate dissemination.

- Fourth, the bill covers not only hardware but also the software, services and training programs vital to a successful overall computer program.

Conclusion

We urge passage of the Computer Education Assistance Act in the strongest terms. The relatively modest reprogramming of federal funds today will reap a harvest tomorrow of workers able to build the nation's service, manufacturing and agricultural sectors. The wide dissemination and use of computer technology and computer knowledge will help our country maintain its economic security.

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Senator LAUTENBERG. Thank you very much, Mr. Smoot.

It's rare that the testimony of four witnesses is so much in agreement with one of us sitting here and, of course, I share the view that each one of you has presented.

I'd like to just ask you a couple of questions, and point out to you that there may be other questions submitted in writing, which we would ask you to respond to as quickly as you can. We're trying to compile a record here that will help us shape the legislation in its final form so that it does the best job that all of us would like to see.

We are constrained by budgetary problems throughout Government right now, throughout our planning. Therefore, we have to make sure, as each of you has indicated, that we use these dollars sparingly and as effectively as we can. We have to make certain that training—the appropriate training is available, that we're not buying hardware that doesn't get used properly, or that we misunderstand—or that out in the field it is misunderstood what the mission really is for this bill and for computer education.

Ms. Borsecnik, some people say that one of the problems with the educational software market is that it's so fragmented. The market for, let's say, the eighth grade science programs is relatively limited. As a result, publishers are reluctant to invest in development for this market.

What's been your experience, and what might we see as a result of the introduction of this into law and perhaps refining the marketplace a little bit.

Ms. BORSECNIK. Well, it's true that the market is somewhat fragmented, and the industry is very, very young. Software production is an expensive process and, as you know, there is considerations by companies about copyright protection and intellectual property protection, which has made many of them hesitant to invest heavily. A confounding problem is that purchasing decisions are made differently in every State, and curriculum requirements vary greatly from State to State. This makes market assessment difficult for publishers.

However, we sincerely believe that the quality of software has increased dramatically in the past few years, along with the technology. But the quality of software is also dependent on the quality of teachers, which relies on teacher training. A software program cannot be used, divorced from the curriculum. We need talented teachers who are well trained to help integrate that software into the curriculum.

Senator LAUTENBERG. You see, within the software industry, new opportunities created that, because of competitive forces, et cetera, within the industry, might even have the kind of effect within the industry that would be beneficial. That is a larger marketplace, more competition, bringing in more resources and that kind of thing and ultimately affording the client, the customer, the school, expanded kinds of software, more sensitive to the needs that we're discussing here today.

Ms. BORSECNIK. Two things. First of all, I think that just the announcement this week by some of the major hardware companies, Tandy and IBM, showed that there is changes in technologies made all the time. Development of software follows computer introduc-

tions and upgrades and obviously, as machines have more capacity, software can take advantage of them. Lack of computer standards is a problem for software developers.

And second, I think that—as I mentioned before—the improvements of software, because it is a new industry, have—the quality of software has greatly improved, and I think most educators would agree with you on that. However, market fragmentation, as already mentioned, is a big problem.

Senator LAUTENBERG. Tell me, what kind of involvement has the industry generally had with teachers, as they developed software, with school administrators and principals, et cetera?

Ms. BORSECNIK. I can give you two examples. First of all, I used to work for a company that developed educational software, and educators were used as consultants all along during the development process. That's standard for software publishers. It's very necessary. Programs are tested in classrooms also, all the way throughout their development.

Second of all, the industry, as I mentioned before, is involved in a project called Computer Learning Month which is supervised by an advisory board of nationally recognized educators. It's an effort to not only include the public in the computer revolution, but also to open up a dialogue between educators, administrators, parents and teachers. Another aspect of that is getting parents involved in Computer Learning Month and computer learning.

Senator LAUTENBERG. Let me ask a question that comes from my old days in the trenches, as they say. What kind of efforts do you see to standardize, if not languages, programs so that we're talking about good compatibility—one of the problems that we have—and particularly with school systems, school districts out there in the market.

Is there enough compatibility, do you think, in the program marketplace that says that a school district that makes a decision about a computer piece of hardware is going to be able to have the array of software that they need to do the job that we're discussing this morning?

Ms. BORSECNIK. For any of the major computer families, right now there is a myriad of software available—for the IBM, the Tandy, the Apples of the world. As long as there are differences in the hardware, obviously that software is not going to be compatible between machines, although most software publishers do produce several versions of each product.

Senator LAUTENBERG. Thank you very much.

Jay, Jay Goldberg—I used to be—you were out of the room—I used to be chairman of this association, I had the job that Jay has today. That was a long time ago. We were, however, already in the computer age.

Senator DODD. There is hope for you, Jay.

Senator LAUTENBERG. You, too, can take a pay cut if you do well.

What do you think kids ought to be learning in the schools? You mentioned in your testimony that the employment market is one that has got to be enhanced by developing the skills. What do you think that the programs for teaching, learning in schools, ought to look like in order to satisfy the recruiting requirements that we will have off in the future?

Mr. GOLDBERG. I think in my mind I distinguish between the basic education in computer literacy and the use of computers in simple day-to-day functions from the integration of computers into the educational process.

And I think if you look at the literacy issue, there's ample hardware and ample software out there to be able to get elementary and high school students to overcome any fears that they might have of the technology, to learn to use computers and applications like word processing, to learn to use data bases that reside outside the computer, using modems and telecommunication lines, and to be prepared for the type of training that they will undergo later on when they enter the business field.

I don't think that the amount of training necessary to get somebody open-minded enough to be receptive to training at a later date is that significant. And I think the fragmentation of the market that we always talk about really rests with those programs that are meant to enhance the teacher. But at the very basic levels, there are standardized packages and standardized hardware devices that people can buy relatively cheaply and relatively easily.

Senator LAUTENBERG. Let me ask you a question about what might happen to us, as a country, if we don't go ahead and do something like this. You said in your comments that the number of jobs off in the future that are going to be created are going to be 65 percent, I think—9 out of 10 jobs between 1984 and 1995 are going to be in the service sector, now 65 percent of the total U.S. population.

What happens if we don't do this? I see companies having to recruit from abroad, nonnative-born people employed in many of the key positions in industry and technology. My State, your State, Senator Dodd, are States that are very much dependent on technology for economic opportunities. What happens to us if we don't do these things? I don't want you to give a treatise, but do you have a kind of synoptic view?

Mr. GOLDBERG. I have very strong feelings about it—on two levels. The first level has to do with competitiveness, and that says simply that the only edge that the United States has, in my opinion, in the coming years in both the manufacturing arena and service arena is technology. Now we have resources, but so do other countries. Our labor is expensive.

From my standpoint, if we can't retain a technological advantage, the hope for the manufacturing industry in this country, I think, will disappear. This is true even in the service sector—my company works in the banking arena, and New York was a preeminent money center 5 years ago—now my customers deal in Tokyo, London and New York equally.

And technology is what drives the financial services market today; if we don't remain competitive and keep our technological edge, I think we're going to lose ground, not only in the manufacturing sector but in the service sector.

I also have a personal feeling and I know, coming from the New York marketplace—a lot of my friends are going to not like what I'm about to say—but the brightest and the best students in the United States today seem to be going into the legal profession and investment banking. In some of the most competitive foreign coun-

tries, the brightest and the best students are going into engineering and technological fields.

I think if you project that trend down the road 10 or 20 years, it's a frightening prospect. And from my standpoint, anything we can do to spark the interest of a young student, to turn him on to technology, to get him interested in the computer as opposed to the stock market, I think will go a long way toward making the country more successful in the future. And I think if we don't, we miss a great opportunity. I think if we don't get the students at a young age, we run the risk of never attracting them to the technology.

Senator LAUTENBERG. Is this country ahead of Japan in computer access in the schools?

Mr. GOLDBERG. I couldn't tell you that. I don't know.

Senator LAUTENBERG. Well, I can tell you that it is. In my view, unless we maintain that edge in the classroom, we will never, never be able to preserve it in the marketplace.

One last question of Mr. Smoot. I was interested in Ms. Borsecnik's response to the compatibility of software question.

Now you represent the manufacturing side of things. Are we able to encourage the smaller, the innovative manufacturer to come into the field with the kind of opportunity that I think will ultimately exist as a result of these programs? I mean this marketplace of itself is not going to be that gigantic. But what rebounds from this, what results from this, can be enormously beneficial in expanding the opportunity for technology.

What happens with the companies who want to compete, though, for this business? Is there an opportunity, if the software compatibility addresses only the largest or the most dominant manufacturer?

Mr. SMOOT. Although our name is Computer and Business Equipment, suggesting hardware, we include software as a part of our purview. I think you cannot do it otherwise. But the trends would seem to be that the educational software publisher, the person who does the software, is going to be the interface between the user and the producer of the boxes.

It might be that school districts in this case should be looking for a solution to an educational problem rather than looking at a list of hardware offerings and buying by least price, and then looking at a list of software offerings.

Instead, they should be looking at a solution. A company may manufacture the hardware and the software; maybe it manufactures the software and buys the hardware from someone else. But its responsibility would be to provide a working solution to the school district.

That's what we see happening in corporate situations, and I think it's a good model for the school systems.

Senator LAUTENBERG. You also mentioned in your comment, the productivity factor. I think all of us see the virtue of this program. We're pleased to have each of you testify.

Mr. Cerf, I found your testimony engaging. The fact is that if it's fun, if we can make it interesting, there would be a lot more people involved—I'm for that—in all kinds of ways, including broadcasting, but we'll not get into that. Mr. Chairman, I'm sorry.

Senator DODD [presiding]. That's all right. Just very quickly, I showed you some of the charts, and you can all quickly respond to this, if you would like.

Dramatic change in five or six years. We were down at a very small number of schools that had any computer at all, and we quickly bridged that gap—not a very difficult gap to bridge, considering that it was a matter of just getting some available in these various schools, grade levels.

The next question is getting those numbers down, the ratio of student to individual computers, getting that as low as we can. That will increase, of course, the comfort, becoming, as I described, the pen and paper, or pencil and paper for the twenty-first century, a child becoming accustomed to that at the earliest levels of their educational training.

It seems to me the most successful way, given the budgets that local school districts and states have, of moving rapidly to fill this gap, recognizing what you said, Mr. Goldberg, that if we don't move quickly into this area, that we're going to leave ourselves in a devastatingly dangerous position, competitively.

I presume that thought is not one that you have alone, but one that is expressed all the time by members of the Association, and part of your work is determining their views. Am I correct in that, that those views are ones that are shared by the majority of the people in your association?

Mr. GOLDBERG. Yes, sir.

Senator DODD. Business has been pretty good in filling gaps, where they've seen the direct benefit to them. We have seen recently, with people like the Sara Lee Corporation in Chicago, adopting inner-city high schools, examples of that in New York City. We have seen it at the higher educational levels where major corporations in this country have now weighed in rather significantly to financially back and support the high tech fields and the like, so that what comes out of those universities will be a product, an employee that can fit right into the corporate structure, or the needs of corporations across the country.

The more difficult problem is getting that corporation to see the direct benefit by investing in a first grader or a third grader. And yet, you've said the members of your association recognize what lays down the road.

Is the problem one that it's not a gap or not a need they can meet in the next quarter or the next two quarters of the year, and that the corporate community only thinks in time frames like quarters and maybe a year or two; that they consider it not part of their function to think beyond 4 or 5 years at all, and so the difficulty of getting them to invest with our school systems at the elementary and middle level and high school level is a difficult problem to sell to a board of directors.

What is the difficulty? Why can't we get more financial participation by the corporate community since they will be a direct beneficiary of this program very, very quickly?

Mr. GOLDBERG. I wish I had a clear answer to that; I can give you an opinion. I think it comes in several parts.

I think we had a comment earlier about the software protection issue. I think it is an extremely important issue. Schools, historical-

ly, have felt that they have the right to copy software without paying for it. That's pervasive at both the elementary, middle and high school, and even college levels—and I think some of the colleges are the worst offenders of this kind of attitude.

From the standpoint of a software vendor, that's a tremendous inhibition to make the investment.

The opportunities in the software world are diverse, and the investment is predicated on people expecting a fair return for their investment. I think it has nothing to do with quarter-to-quarter issues. There are thousands of developers who have opportunities in front of them, and they are choosing them based on which ones they feel will yield the greatest return. I think, first of all, that's an issue that has to be addressed.

Senator DODD. That is the computer industry. Why isn't United Technologies in Hartford or the Travelers or the Etna, or the New Jersey Corporation, other than using computers, why aren't they weighing in more heavily to fill this gap?

Everyone knows the problem—you can't get boards of education to raise money. States are reluctant to invest dollars in areas that seem iffy, particularly when there's a generation making the decision that doesn't know what these things are, let alone what they can do. Why isn't the corporate community, which is aware of what they can do, recognize the need, why are not they weighing in to see to it that we reduce substantially that ratio of computer to child?

Mr. GOLDBERG. Obviously, the computer manufacturers are—you are raising the question about the companies?

Senator DODD. Generally, right.

Mr. GOLDBERG. Some of them have made an attempt—companies like McGraw-Hill have made an attempt, but the software industry, maybe because of its infancy, is still a very entrepreneurial business, and if you look at the largest software companies, their sales are measured in the tens of millions of dollars, perhaps $100 million.

When you compare that to the sales of some of these large companies that you describe, like United Technologies, the impact on those companies is insignificant, the risk significant, and I think they're not entrepreneurial enough to be able to seize the kinds of opportunities that present themselves in education. It's very dynamic, very fast moving—technology is changing very, very rapidly.

Most of the large companies that have tried to enter the marketplace, as Senator Lautenberg will confirm, have failed. And that is in the commercial market, as well as the education market.

Senator DODD. Let me ask the other ones if they want to comment on that. Mr. Cerf, do you want to comment on that at all?

Mr. CERF. Well, I think the problem really is, and if you look at a business my size, it's an even bigger problem. There is no way that I can do anything except try to see the needs that are there. That's why I mentioned research earlier. The more that we know about teachers' needs and the more that we can train them, then perhaps companies like mine, or others that size, can develop materials to help teach teachers how to use computers and to be less scared of them.

I think, just commenting on what some of the other people said, that perhaps the biggest danger here of all to the country—to answer your earlier question—is that this technology could go the way of, say, the sound film strip projector did a few years ago. A lot of teachers that I've talked to tend to see this as a gimmick, very much the way they saw some of the audio-visual things that were introduced in the brighter days of Title One and all of that.

That is very dangerous because if this stuff does end up on the shelf, the country, industry and our competitiveness are going to suffer greatly. I think it's important for people to realize that, yes, it's a tool for learning and an enjoyable one, but it's also an absolute necessity that people learn these things.

Therefore, it is incumbent on industry, on Government and all to make sure that teachers are trained adequately to use this equipment and the software that goes with it. I think part of that effort has to come from software developers who have to develop software, not just that the kids will enjoy, but that teachers can understand.

We can even develop videos, and some companies like Sunburst are doing that, or the Bank Street College is developing videos to help teachers learn how to use these materials. We can create software, in effect, to teach people how to use—or to teach people how to teach the software.

Senator DODD. Let me make another crack at this thing, because I'm not getting across, apparently.

I understand the problem the software industry has and its reluctance and so forth because of the patents and the like, and the copying that goes on. I'm not talking so much about the software industry as weighing in more heavily.

I'm talking about why isn't corporate America—exclude, if you will, the software industry—why is not corporate America, where you have a pool of people?

I remember CBS Studios, their labs are located in Stamford, Connecticut, on their own—a $60,000 investment is what it cost them—but the personnel in those labs decided for a year to try something. They went and they started teaching science and math at the middle schools and elementary schools, state-of-the-art science in these schools, volunteered weekends, afternoons. They worked out their schedules so they could do it.

Here were knowledgeable people who needed to learn some rudimentary teaching skills, in some cases; many did not at all, they fit into it very easily, went right in and made a difference immediately.

What I want to know is, why aren't there employees of some of these firms who could easily be teaching? You don't have to go to the software industry today to train teachers. You've got them in every city in this country, where you have industries today that are using computers. These employees could be doing more on behalf of the corporate community, it seems to me, financially, to support the educational needs of our school systems, inner cities and the like, especially where the computer/pupil ratios are particularly poor.

Why is not that happening? That's what I'm asking; not why the software industry is not doing more. Why is not corporate America

weighing in when, if you're correct, they understand the danger of having a computer illiterate constituency coming up in our society at a time when they need to be extremely literate in this particular educational means.

Mr. GOLDBERG. You just made the case for the Government. For corporate America, and I'll call on my experience as a CEO of a pretty good sized company, it's just too peripheral an issue, it's just too far removed from supplying a direct need.

You said it—why is corporate America, and we can get into that, thinking in such short terms? Because that's where the focus is. To get it down to the elementary schools, it's those in Government, the Federal Government and the State government, who are going to have to pick up that responsibility. It's just not realistic to expect industry to solve this problem without government leadership.

Senator DODD. One last question that I have, and that is I have a deep interest in foreign language training. I was intrigued to hear you talking about the audio capacity of computers. Again, going back to the competitive factors, what is the state of the art in software on foreign language training in our school system as part of the educational program?

Mr. CERF. I could take a crack at that. I'm not a total expert on all of it, but it's coming along well. I think a couple of developments in technology that we're going to see more and more of in the next few years are going to make this even more important.

The fact that the CD, the common CD or compact disc, can be used as a medium to store computer data in huge quantities and is also an interactive audio device has tremendous promise for us, as does the video disc a little bit further down the way. The fact that some of these things are catching on in other markets is very important to us also. The fact that CD has worked as a pure audio player has driven the interest in what's known as CD ROM, which is computer storage on the very same technology.

As you yourself said, Senator Lautenberg, we're only in the infancy of this now. I think the technology that's in schools, like an Apple computer, for example, the Apple II, at least, is really not equipped to do the job totally, though we can do lots of things in the drill and practice area, and we can make them a little more amusing with good software development.

But I think it's in the next few years that we're going to see huge steps here, because we'll have interactive audio and video which, in effect, just means tying those storage devices and those other media to computer control.

Senator DODD. You wanted to comment earlier, and I apologize.

Mr. SMOOT. I guess I would like to make a plea that we not forget the manufacturing sector. I think we all watch the curves and we see the growth of the service industry, but when we talk about competitiveness we are including manufacturing and that includes some pretty basic operations.

The point is that computers are being applied to those operations also. So the educational point, I believe, is that we shouldn't think of computers, even in the kindergarten through twelfth grade in school, as applying only to the office environment. We need to worry about the teaching of computer applications in the auto shop

classes and in the schools that are aimed at kids who are going to be on the factory floor. Those people are going to deal with computers as much as the rest of us, and we have to keep their concerns in mind when we talk about integrating computers into the educational process.

Senator DODD. Thank you very much, and I thank all four of you for being here this morning helping with these hearings. We may have some additional questions for you which we will submit to you in writing. Indeed, the other members may have some additional questions, but we thank you for coming. Thank you very much.

Our next panel of witnesses are Connecticut and New Jersey administrators, teachers and students. I'd like to invite Dr. Linda Naimi, the State coordinator for Computer Education Programs for the Connecticut State Department of Education; Mr. Dan Barstow, the Coordinator of Gifted and Talented Programs, the city of Hartford; Jeff Bernhard, teacher at the Bernard Brown School; and Juan Diaz and Leticia Davila, who are students from Hartford, Connecticut.

Before we begin, what I'm going to do is have Senator Lautenberg take over for a bit here. I have been called to the Majority Leader's office for a meeting with some people from the White House, so I'm going to have to take a few minutes and be away—at a time when I've got all my Connecticut constituents here before me, but I'll get back as quickly as I can.

I want to welcome you, though, and tell you how deeply appreciative I am for your being here and coming down and sharing with Senator Lautenberg and this committee the Connecticut experience and what's going on in our States.

You can begin with your testimony. It's conceivable that by the time you get through with your testimony, I'll be back for some of the questions. But with that, I am going to turn the gavel over to Senator Lautenberg.

Senator LAUTENBERG [presiding]. And Senator Dodd has turned over the same rules to me that he invoked at the beginning, and that is that we're going to have to restrict you because of the numbers to five minutes, and the clock will tell the tale. So we invite you to give us your testimony and look forward to it with interest.

I guess we will start in the order that you were called up. Dr. Naimi, if you would go first—oh, you are going to go first, Mr. Barstow. Please go ahead.

STATEMENTS OF DAN BARSTOW, COORDINATOR, GIFTED AND TALENTED PROGRAMS, CITY OF HARTFORD SCHOOL SYSTEMS, HARTFORD, CT; LETICIA DAVILA, STUDENT, HARTFORD, CT; JUAN DIAZ, STUDENT, HARTFORD, CT; DR. LINDA NAIMI, STATE COORDINATOR FOR COMPUTER EDUCATION PROGRAMS, CONNECTICUT STATE DEPARTMENT OF EDUCATION, HARTFORD, CT; JEFF BERNHARD, TEACHER, BARNARD BROWN SCHOOL, HARTFORD, CT

Mr. BARSTOW. Good morning, my name is Daniel Barstow. I am the coordinator of Gifted and Talented Programs for the Hartford Public Schools in Connecticut. I am also project director of "Encen-

diendo Vnallama," a bilingual gifted and talented program that is a national demonstration project, funded with Title VII Bilingual Education funds.

I believe that our role here is to bring all this to life. You've been hearing from the industry. You've heard a lot of facts and figures, but we have students and teachers who've been involved in using computers, and we'd like to get into some very specific examples to bring this all to life.

First of all, to provide a context, Hartford is a large urban district, primarily black and Hispanic students, a total of 25,000 students in 30 different schools.

I represent the Gifted and Talented Program, where we serve approximately 1,800 students, and we are the largest Gifted and Talented Program in the State.

In the city, we really have made a varied use of computers in a wide range of fields. I'd like to focus on the areas in the Gifted and Talented Program, although understand that there are many other aspects of this use. One of the points that I'd like to make is that one of the reasons that we have had some success is through the cooperation of a variety of resources, including Federal funds, State funds, local funds and private industry.

One of the things that we've seen is the transition from the early stages of "Gee whiz, isn't this neat," and the drill in practice and games and things to real, effective use of the computer as a tool.

I guess I'd like to ask—I assume you have a computer in your office. And I'd like to ask the people here, how many of you have in your office, in your home? Obviously, this is an essential tool that we can't live without, and the students are finding it to be the same way.

I would like to focus on several specific different applications. One is word processing. The students are using it to create school newspapers, write letters to friends, write poetry. It's a tool that helps them in the creative writing process.

Leticia Davila, who is here on my right, will be reading some poetry that she's written and that she's had published in this book. It has even been some award-winning poetry that she will be reading when her turn comes along.

Another aspect is the use of the computer as a tool for research. Using a program such as Appleworks, it's very easy for students to collect data. Perhaps they will do a student survey, ask their friends some questions, store the data on the machine and then analyze it.

Leticia, mentioning her again, has used some of her experience, now working this summer at Hartford College for Women, analyzing data, using her background in that area.

Another very exciting aspect is the use of telecommunications. Now for those of you who aren't familiar with telecommunications, very simply, it is connecting up your computer over the telephone lines and that opens up a universe of possibilities.

We received a grant, partly from the State and partly from MCI Mail, which has generously offered their support. We have free access to their network, and through this network students log onto the computer and they send a message. It goes out over the

telephone lines, and they have communicated with friends in Oshkosh, Wisconsin; Fort Lauderdale, Florida, and even Hong Kong.

You will see on your desk a packet of materials in the blue folder, and among those materials includes some reprints of articles that have appeared about this exciting project, one of which is an article that appeared in the New York Times.

If I can just make some quotes from that of some of the students' comments.

> Students at two schools were sending messages back and forth and, understand, these students had never met before. They send messages, for example, "What will people do for fun in the Year 2000." One response was, "No cars, only monorails." Seconds later, in the other school, the student responded, "Sky Bowls instead of Super Bowls," and their conversation continued.

The principal at that school, along with the teacher, have clearly stated that this has been a powerful way for them to develop their language skills.

Another example, using the MCI Telecommunications Network: there are a lot of famous people on this network, and the children sent some messages to Steve Wozniak, who is the inventor of the Apple computer. He, very graciously, friendly, responded in very personal terms with the students.

They asked him how old he was, what he did, and if he lived in a mansion. He said he just lives in an ordinary house. He also commented that "In high school the smallest computers cost as much as a house, but I decided that some day I would skip having a house and buy a computer instead. I was not what you would call normal."

So they've had contact in a way that they can't in any other fashion. They walk into the school's doors and a whole universe of possibilities opens up to them.

Building on that telecommunications aspect, we recently received a grant from the Hartford Jaycees, building on the local support, to expand——

Senator LAUTENBERG. You've got a couple of seconds to wrap up, Mr. Barstow.

Mr. BARSTOW. Let me conclude. Later we will be doing some demonstrations of programs and things and mentioning the students. But I would like to say, in conclusion, that the computer is an essential tool that is especially serving historically underserved populations such as our minority population in Hartford, and it has been a very powerful tool for finding new opportunities.

There is an important role for the cooperation of the State, the Federal Government, the local government, and this bill is one piece—not the whole piece, but an essential piece.

Senator LAUTENBERG. Thank you very much.

Ms. Davila.

Ms. DAVILA. First I'll start off by telling you something about——

Senator LAUTENBERG. Bring that microphone close. We're all anxious to hear what you have to say, so speak up. We're proud of what you've done. You should be proud of what you've done, and we want to hear it.

Ms. DAVILA. Thank you. My name is Leticia Davila. In September, I will be going into the ninth grade at Hartford Public High School. I have been educated around the USA and Puerto Rico.

Among many interesting things that we do at school, the use of computers has offered the greatest challenge to me. I have learned to program in the logo and basic languages. I do a lot of graphics in those programs, but I use the computer most for my writing.

Using the computer is a great advantage. The word processor allows me to be creative. It offers me the flexibility of being able to change my mind by changing or improving my ideas. It allows me to correct my mistakes as I go, or to come back later to finish the work I have saved.

My poetry—that's what I do a lot—has been entered into many contests. One of these was Young Writers of Virginia in which I was a finalist. I have had my work published in magazines and in local periodicals. This year I submitted my work to the Trinity College Literary Contest for the Classical Magnet Program where I won second place and received a $50 cash prize.

Working with our school's publishing company, I contributed to an Anthology of Poetry by the gifted and talented students, and I also published my own book which you saw before.

I would like to read a little poem for you. It's called Creatures.

Creatures of darkness, creatures of light, because we kill you does not make it right. Rabbits for fur, deer for heads, we slaughter them but not for survival. It seems we kill you more and more, and the lies we tell ourselves. We try to say, "Sorry," but it doesn't work because we can't say no to the face of extinction.

Senator LAUTENBERG. Wonderful.

Ms. DAVILA. I get thoughts from all sorts of statements or things that I hear on TV or stuff like that.

Senator LAUTENBERG. Excellent.

Ms. DAVILA. Computers in our school help the bilingual students because they open up more and they ask for help, and it also helps them learn English, because we have a lot of minorities in Hartford.

We use computers in everything, farming, business, government, banking, grocery stores, music and communication with other countries. Isn't it time we start using them in education, to prepare kids like me and my friend Juan for a life in a technology filled society? Computers are fun and easy to use, and it also helps teachers. But it's not all fun and games—you also have to learn how to use them to prepare for the working world.

Because I've had so much knowledge with computers over the last few years, I was able to get a job at Hartford College for Women working with the computers there. So it helps me because when I graduate and go to college, I will have a better chance of getting into the college and having a better job waiting for me afterwards.

So I think that computers are necessary for schools, to help the kids learn more about them and to be prepared for the living world that they're going to be going into. Thank you.

Senator LAUTENBERG. Excellent, Ms. Davila. You're not going to have any problem getting a job, I can tell you that. We may have a couple for you here.

Are we next going to hear from Juan Diaz?

Mr. DIAZ. My name is Juan Diaz. I am 14 years old and I am going into seventh grade in Hartford, Connecticut.

Working with computers is very exciting. Years ago, I was very scared of computers. I always felt I would break them. Now I am very comfortable programming in logo and logo writer, doing word processing and just working with the computer.

One of the six things I have done on a computer is learn Logo. Logo is a computer language which uses geometric figures to make a well-developed program. I learned how to write small procedures which later I put into one large program. It helped me see what different angles looked like and taught me how to write a program. It really made me do a lot of thinking.

Another part of Logo which I just learned was Logo Writer. With Logo Writer I did word processing. I wrote stories, post cards and other types of writing. I like this program because I can correct all my mistakes without rewriting the whole story. I was able to change, erase and move whole sentences and paragraphs to make what I was writing more exciting.

Other things that I have worked on with computers are make word finds, cross-word puzzles and making a play. I developed a play with the help of the gifted and talented teacher. The play is about three men working, plus studying about a volcano. I had to do the research in the library and write the play on the word processor.

I also worked on a weather program where I had the computer call up the Weather Service with the use of a modem. I kept charts, maps and graphs to see how weather patterns move.

Computers have helped me write better and think more clearly. I hope I will be able to use computers in the future. Thank you.

Senator LAUTENBERG. Very good.

I don't really think these are students—I think you got these youngsters from Central Casting. Terrific.

Dr. NAIMI. We're going to have a brief demonstration, and I'll make a few brief closing remarks.

Mr. BARSTOW. I would like to show you a demonstration of computer programming done by the students and myself a few years ago. This is an example of creative, artistic and academic creativity on the part of the students.

The program is an adventure game, and the idea of an adventure game is to go exploring. The place we will be exploring is the city of Hartford. This program was written over the course of 6 months with a group of students in the Bilingual Gifted and Talented Program.

I should mention that the Bilingual Gifted and Talented Program is funded with Title VII funds, and recognizes that bilingualism, as Senator Dodd was mentioning earlier, is an intellectual asset and not a handicap.

The program has several unique features, one of which is speech synthesis and, as you heard, it spoke out loud and said, "This is a map of Hartford, Connecticut." Another feature is the use of a light pen, which is a device that you can point at the screen and the computer knows exactly where you're pointing.

You will see as I trace the route down Main Street, cut across on High Street, in through the park, move along. We end up, for ex-

ample, here. This location is the library. The scene changes and we are now on Main Street in Hartford.

There is a Spanish version of this program; simply by inserting a different disk we get the exact same program in Spanish. And we get the choice of going into one room or another. Let's go, for example, into the door on the right.

Senator LAUTENBERG. It's not a real time program.

Mr. BARSTOW. The scene changes—and I should mention that the pictures were all drawn by students. Francisco Caban was the special student who was involved with this, and he used a graphics tablet to draw these pictures.

We get our choice of learning about different parts of the library. If I point, for example, to that object in the middle, we find out that this is the card catalog. You use the card catalog to find out what books the library has and where to find them, and it lists some good books that are in the library.

If we point at the librarian in the corner, we get a choice. We can tell her our name, ask for help finding a book, get a new library card or borrow a book. Why don't we ask her for help finding a book? What book would you like to find—and I'll ask you, Senator. Is there a particular book you would like to find in the Hartford Public Library?

Senator LAUTENBERG. Is this a children's——

Mr. BARSTOW. This is the children's part.

Senator LAUTENBERG. "Black Beauty." Does that date me? That was way before computers, I can tell you that.

Mr. BARSTOW. On the right, the librarian has moved her desk over to the book shelf. Here it is—"Black Beauty" is a good book. I hope you like it. For those of you who are seeing the display there, the actual display is in color.

We will try one other location. You might wonder, "What is that box on top of the card catalog?" This is the fish tank. You may, one, look at the fish; two, touch the fish; three, read about the fish. What would you like to do?

Senator LAUTENBERG. Eat the fish.

Mr. BARSTOW. We'll choose touch the fish. Oops! this fish is a piranha fish. It eats human flesh. One moment, please. Chomp. The fish just ate off your hand. That's one of the humorous touches that our students put into this program.

There are other parts of this adventure, but this concludes the demonstration of this program.

Senator LAUTENBERG. Thank you very much. It's very interesting, and it does engage, obviously, the interest of the youngster. That's a wonderful way to do it. The speech synthesizer—we used to use that some days just before I left the business world in 1982, and it's very handy.

Dr. Naimi, I keep wanting to get to you. Do we now have our opportunity?

Dr. NAIMI. Yes, Senator. I hope you were waiting for me because of anticipation.

My name is Linda Naimi, and I am the State consultant for Computers in Educational Technology in Connecticut. I joined the Connecticut State Department of Education a little over a year ago, having come down from Harvard University where I served as a

director of computer services while completing my doctoral program at the Harvard Graduate School of Education. My interest in education technology has been lifelong. I've been involved with computers for more than 15 years, and I have been a teacher most of my life.

The role that I currently see for the teachers and students here with me who are representing those teachers and students back home in Connecticut is to emphasize to you the extreme importance with which we view the potential for educational technology to meet many of the needs of our schools. We have been working diligently toward the goal of having comprehensive, well-integrated, compatible, and articulated instructional programs building on the versatility of microcomputers in all our schools. It is a long and complicated process. And our schools cannot acccomplish this aim alone.

We are seeking to develop more partnerships with business and industry, and we have worked on many levels to promote these projects. Granted, school-business partnerships are not as long-lasting nor as deeply involving as we would prefer, but we do have some special projects in which business and industry have worked with us, like the Celebration of Excellence, or Mentor Programs. Upon later questioning, I would be very happy to explain some of those activities.

We have projects going on throughout the State that deal with everything from in-state distance learning applications—where we tie together schools that might have shortages of teachers or low coarse enrollments in special subject areas—to telecommunicating with other school systems around the country or overseas. For example, we currently are linked with schools in Puerto Rico, England, and Canada.

In Connecticut, we have computer-based programs that deal with bilingual education, multicultural experiences, and foreign language programs for our children. We are slowing incorporating computers into every aspect of instruction, every ability level of our students, and for every subject area. Special education, for example, is a truly needy area, and one in which we are trying to develop innovative programs at all grade and ability levels.

We also have the unique opportunity, because of Connecticut's diverse population and the local autonomy of our school systems, to have a rich resource base of individually crafted, uniquely implemented programs that are serving as models around the state as well as around the country. But we have many schools that are falling behind in this movement because of lack of funds, resources, leadership, or direction. The gap has widened between those schools that have the resources to make significant strides in educational technology and those that do not. We hope to bridge this gap, and with aid and support, such as in this bill, we can make equity a reality.

In a recent campaign called Profiles of Connecticut Schools, we began assembling a variety of materials from schools which are using computers in instruction. We have at our disposal a variety of integrated curriculum guides, where schols have started that initial process of turning from a strict programming/computer science slant to thinking more in terms of functional applications. The first

approach deals with learning how the computer works and how to make it an additional part of the daily instructional process. The second and preferred approach focuses on how to use the computer as a learning tool, to help us to improve our effectiveness in reaching students and in having students able to learn more independently and responsibly on their own. Our slogan is: "Moving beyond the three R's to the three E's: Equity Excellence, and Enthusiasm in Education".

Toward that end—and I am going to summarize quickly—we have a major philosophy regarding appropriate uses of computers in instruction. I guess this statement summarizes our approach better than anything else I can say. This statement of philosophy comes from Darien Public Schools, and was presented by Judith Crawford, the district computer coordinator. It reads:

> The computer is a tool which will enable students to more efficiently and effectively solve problems, develop logical thinking skills, organize and process information, communicate ideas, accomplish tasks, learn new information, reinforce prior learning and apply new technologies to future life situations.

It is in this arena or creative atmosphere that we are seeking to use computers now.

Looking at the long term, something must be done to help our schools effectively, systematically, and universally integrate computers into the instructional process. We are facing a tremendous variety of problems in education as we struggle, seemingly alone, to take advantage of an innovation that has become commonplace in nearly every other sector of American life. We must look to the needs of our children and prepare them for a future that will inevitably call upon special knowledge and skills in the twenty-first century. Schools cannot do it alone.

Someone said educational technology was in its infancy. I would say that we are not in our infancy, but rather in the toddler stage—heading toward our own "Head Start". We want to be in a growing phase now. We have gone through the early learning curve.

As educators, we know what we want and we know where we want to go. We want to promote equity and excellence in all our schools. We want enthusiasm in our teachers and our students. We want to revolutionize the educational process. Computers are a great learning resource. And our children should not be deprived of a better education because of lack of funds or commitment.

Now we need your help and the means to achieve these goals. We need funds, support, and commitment from various groups and organizations . . . in short, everything that one would normally call upon to build that support network to help us see this movement through to fruition. We need Congress's attention and support now.

I have brought with me some letters from educators in Connecticut who are voicing their support for legislation of this kind to aid the schools in improving the instructional use of computers. I will submit these to you at the end of my testimony. Also, I have a brief paper that will serve as an introduction to some of the things Connecticut is planning for the future regarding educational technology.

On behalf of the Connecticut State Department of Education and the thousands of committed educators and industrious students in our State, we thank you for inviting us to testify before you. We are very, very thankful that these initiatives to support computers in the schools are coming back again for consideration and hopefully, passage. We thank you for placing education again high on the Nation's agenda, as it should be and must be. Thank you very much.

[Information supplied follows:]

PROPOSAL:

A VISION OF EDUCATIONAL TECHNOLOGY IN CONNECTICUT

by Linda Naimi

Introduction

The ideas presented in this paper represent an agenda for the future of education in Connecticut schools. It is time for us to consider what education and society may be like in the twenty-first century (scarcely thirteen years away) and to take appropriate actions now to shape that future. The possibilities for meaningful change are limitless.

Some exemplary educational reforms are already in place: principal mentor program, celebration of excellence, certification and CEU standards, teacher mentor program, common core of learning, the Commissioners' Six-Point Agenda, etc. Nearly all areas of the educational process are undergoing refinement, save one: educational technology. It is that area which this proposal addresses. If we are to realize our goals of "equity, excellence, and enthusiasm" in education, we must begin now to tap the wealth, resources, energies, imagination, and expertise of Connecticut's educational and business communities. And government must show dynamic leadership, vision, and unswerving commitment to this reform effort. If we do so now, within the next decade Connecticut will be able to take its rightful place as a leader and model state for educational excellence. Let us move forward together.

Background

The current status of educational technology in the state highly diverse with programs varying in quality, quantity, use, and longevity. The disparities between the well-endowed schools and those financially less fortunate have been more clearly defined with the introduction of computers and related technologies in the schools. In many cases, computers originated in the math and science departments at the high schools, and then worked their way across and down the educational spectrum to the elementary grades. But in a relatively few districts, the scenario is reversed. It is generally true that computer-based instruction has been "patch-worked" into the educational process and provided to students and teachers in undigestable and isolated chunks. Efforts must be made to design a coherent, integrated, and comprehensive approach to computers in the curriculum that covers a K-12 program of instruction.

The most dramatic moves toward embracing technology appear to have occurred in the southern part of the state. Schools in the "gold coast" region have made substantial investments in technology: sporting computer labs, computers in the classrooms,

broadcast studios, media centers, and sizable libraries of software and video materials. However, the uses of computers and media in these schools varies greatly. Some have attempted to "integrate" computers into the curriculum in specific subject areas or specific grades, but by and large, computers still remain primarily remedial or reward tools, used separately from class instruction.

Schools in the large urban areas differ greatly in terms of technology holdings and usage. The level of computer use and sophistication in these schools is often a reflection of administrative positions regarding such technologies. Where administrators have felt positively toward the use of computers in their school's instructional programs, the funding has been present for such purchases and teachers have felt encouraged to seriously adapt classroom instruction to utilize the computer. Where administrators have been opposed, computer purchases have been few and far between.

Small towns and regional school districts (particularly in the northwest and northeast) have had the most difficult time in making any meaningful progress in the acquisition and use of computers and media technology. In some schools, computers are viewed as "enrichment activities" which divert needed monies from other projects. In other schools, teachers and administrators have shown a willingness to introduce computers into the instructional process, but have been unsuccessful in convincing the school board or town council that it is a sound investment. In most circumstances, the controversy is exacerbated by the lack of a computer coordinator, the lack of a sound plan, and by the lack of information concerning what other schools in the state are doing in the area of computers and educational technology.

The most recent comprehensive survey of educational technology was completed in 1981/82. Unfortunately, it deals with aggregate figures and brief general descriptions of computer use in Connecticut schools. What we need to know is how computers are being used in our schools today and where do we go from here.

With the changeover of technology every two-three years, the situation has dramatically changed. The early "bandwagon" calling in 1979-82 to introduce computers into the educational process lost its momentum in the period 1983 to 1985. This was due in part to reductions in federal and state funds for microcomputer use in education. But it was also influenced by poor planning on the part of local schools which has inevitably led to a host of lingering problems: inappropriate hardware and software choices, lack of quality educational software, lack of teacher training, inexperience with the new technology in an educational setting, insufficient numbers of computers to meet high expectations, and cost. However, it appears this "growth" time has been valuable

learning time for educators are now beginning to exercise a more cautious and informed approach to using microcomputers in the educational process. In 1986/87, a renaissance in educational technology has begun in Connecticut. We are moving once again.

LAYING A PROPER FOUNDATION

Goal: Regional Computer Councils

Purpose: to encourage sharing and cooperation among school districts in the area of educational technology. These councils will establish more frequent and coordinated contact among representatives of school districts in the region in order to promote better planning, more effective utilization and sharing of available resources, increased knowledge about what other schools are doing, more consistent information flow, and to establish a support network for schools as they embrace educational technologies.

Recently, computer councils were informed that the state consultant for computers has worked out an agreement with Apple Computers which permits school districts to "pool" their purchases at the regional level by channeling purchase orders through the RESC representative. The RESC must agree to handle all arrangements of the orders and to provide "extra value" in the form of training, installation, support services, etc. to participating schools. In this way larger discounts on purchases can be realized by participating schools, the RESCS will earn additional monies through services rendered, and Apple will sell more computers and peripherals to schools. While computer councils and RESCS have been informed of this arrangement, no one has yet taken advantage of it.

Strategy: The state consultant for computers and educational technology is working with Media and/or Computer coordinators from each RESC in creating and supporting these computer councils. Each school district has been asked to send one delegate to the council meetings (delegates may be permanent representatives or designees on a rotating basis). To date, RESCUE has established a Computer Council in the northwest corner of the state which meets monthly (no membership fee). CREC has established a very active Computer Council in the capitol region which meets monthly and every school pays $50 per year to participate.

CES in Norwalk has a Task Force that meets quarterly (member schools pay a fee of $200 to participate). I am suggesting this council meet more often and permit greater representation from area school districts (i.e., lower their

membership fee to encourage more school districts to join). EASTCONN, ACES, and Project LEARN are in the process of establishing regional computer councils at this time.

Goal: Inter-district Cooperatives

Purpose: to encourage small towns and regional school districts to form cooperatives as a means of facilitating their common goals. Funding considerations and lack of information concerning what the rest of the state is doing are two major problems facing small town school districts. Most have no computer coordinator and no sound development plan for integrating technology use into the school curriculum. By pooling resources, these small districts will be able to accomplish some of their goals, develop strong bonds of mutual interest with participating districts, and improve their instructional programs and inservice training programs.

Strategy: to make available incentive grants to these cooperatives to fund joint efforts to develop and coordinate computer-integrated programs and related services.

Goal: Sister Schools

Purpose: to link well-endowed schools with less well-endowed schools in a "sister school" relationship that fosters sharing, cooperation, and the development of a strong support network. The Sister Schools program will enable late starters to learn from experienced schools in implementing educational technology plans. It will also encourage a pooling of purchases as well as resources, which will narrow the acquisition gap between well-endowed and less well-endowed sister schools. There will be no need to reinvent the wheel if it rolls freely between "sisters". This is a variant of the "buddy" system.

Strategy: to encourage successful, well-endowed schools with solid technology advantages to "adopt" a less well-endowed school through persuasion and incentive grants.

Goal: District Computer Coordinators

Purpose: to encourage all school districts to hire district computer coordinators to manage and coordinate all aspects of computer use in the schools. In order to ensure strong articulation from K through 12, planning, curriculum development, support, and coordination must come from a district level. Small towns are being encouraged to pool funding to hire an "inter-district" coordinator to see to their mutual and individual technology needs. Some schools have hired part-time or contractual consultants who offer technical advice and expertise and in some cases training. Other schools have no coordinator or

consultant and are "standing pat" on the issue of technology. Certainly, an "wholistic" approach to technology in the schools requires planning and guidance beyond that which the classroom teacher or the school administrator can offer. District computer coordinators are essential for comprehensive technology programs.

Strategy: State consultant and committees from the Technology Advisory Council will work with school district administrators in securing experienced computer coordinators. At issue here is whether state guidelines should be developed for establishing "certification requirements" and/or "a credentialing process" for these coordinators or school districts should continue to rely upon their own criteria for such choices.

Goal: Schools - Resident Experts and TUGS (Teacher User Groups)

Purpose: to encourage schools to utilize computer-using or computer-knowledgeable teachers as inhouse resources and to provide opportunities (i.e. release time) for these talented teachers to expand their knowledge and skills so they may serve as "resident experts" in the use of computers in the schools.

Second, schools should encourage interested teachers to form computer support groups (TUGS) in order to facilitate software evaluations and selections, cooperative brainstorming and the development of creative computer-based lesson plans or activities, the matching of scope and sequence objectives with appropriate software, inhouse support for teachers learning to use computers in their classrooms, and to serve as an advisory group to the principal in the making of policies and budget proposals on educational technology.

Strategy: to persuade teacher and administrators to volunteer their time and talent to work cooperatively in building a solid foundation at the building level for the integration and use of computer technology in the instructional process. In the process, members of these support groups will lead their schools and colleagues into a new vista of opportunity and innovation as they become more knowledgeable about maneuvering in world of high technology.

Goal: Profiles of Connecticut

Purpose: to showcase exemplary programs and excellence in educational instruction and leadership in our schools. There are teachers and administrators in the state who exemplify the qualities, vision, and leadership we call "excellence in education". Yet, they often go unnoticed beyond their school or community. There are schools that have developed marvelously creative or innovative programs which have proven highly successful (locally), and yet we have not heard of them. The

"Profiles of Connecticut" program is one means of recognizing those leaders and programs in each school which characterize the spirit of excellence and innovation as we have come to define it.

Strategy: The state consultant for computers and educational technology will collect materials from every school in the state which will then be assembled to provide a realistic "profile" of each school and those programs and persons which have contributed to excellence in their particular systems. The materials will include snapshots and photographs of students and faculty actively using computers and related technologies in their natural settings, labeled for ease of identification. In addition, supporting materials such as curriculum guides, lesson plans, activity sheets, and student work which utilize technology in the instructional program will be gathered. Persons responsible for exemplary programs and descriptions of these programs will also be supplied.

Complete profiles (photos, documents, personal biographies, and program descriptions) will be placed in notebooks according to an alphabetic listing of towns and districts and made available for public inspection. Copies of completed volumes may tentatively go to the Commissioner of Education, Governor of Connecticut, Speaker of the House, State Library Board, and Division of Curriculum and Professional Development. Outstanding programs will be highlighted in several of the state's educational technology newsletters.

Goal: Curriculum Resource Library and Technology Preview Center

Purpose: to establish a resource library containing technology-integrated or technology-using curriculum guides from all school districts in the state and resource materials on educational technology from other states for permanent display in a designated section of the state department of education. This curriculum resource library will be used by state department officials, consultants, and other government officials as a means of familiarizing themselves with what particular districts are doing in the area of educational technology.

Second, adjoining the curriculum resource library will be a technology preview center consisting of several computer systems and a wide selection of educational software (K-12, special education, and adult education) for "hands-on" use, exploration, and demonstrations by state government officials and consultants.

Strategy: The state consultant for computers and educational technology will collect curricular materials and photos from every school district in the state on programs of excellence and will work with each school in collecting and assembling such materials. As the materials come in, they are being housed in the

unit for Learning Resources and Technology, given that no library facilities currently exist to handle them.

The state consultant for computers and educational technology will also work with computer vendors, dealers, and manufacturers in order to obtain recognition of the state department of education as a Preview Center and to acquire donations of representative hardware and software for display and hands-on exploration at the state department building. A list of current holdings in the curriculum resource library and in the Technology Preview Center is being prepared.

Goal: School-Business Partnerships

Purpose: to encourage schools and local businesses to work cooperatively on educational enhancement projects and to exchange information and assistance in order to achieved desired outcomes. The emphasis is on partnership, not "adopt-a-school".

Strategy: to assist schools in contacting local businesses and making arrangements for joint action on particular projects, including: creation of computer labs, acquisition of technology hardware and software, shared tips on effective management, writing sound development plans, locating funding sources, initiating co-op programs for students (use computer skills learned in school on part-time jobs in local firms), and expanding high school computer education programs to include realistic applications and uses of computers in the public and private sector through "Mentor-Apprentice" programs or community projects, etc.

An Agenda for the Future

Goal: Bureau of Educational Technology

Purpose: to provide more systematic, comprehensive, and better coordinated services to schools, to articulate state policies and guidelines, and to demonstrate leadership in the field of educational technology both within the state and as a representative of the state in national forums. Given the growth predicted in this area over the next few years and the increasingly important role it will play in our changing society, it is essential that we grow with the technology, needs, and demands. The present organizational structure is inadequate to meet even current needs and expectations. A Bureau of Educational Technology is imperative.

Given that educational technology is multidisciplinary, (i.e., it touches every section of the educational process

including pre-school, elementary, middle, and high schools, higher education, adult education, special education, etc.), a bureau of educational technology will permit a more reasonable division of labor and a more consistent "wholistic" approach than is currently the case. Connecticut is one of the few states that does not have a separate bureau of educational technology, and it is to our detriment.

Strategy: to establish a new bureau of educational technology in the state department of education. The bureau chief will work in concert with the bureau chiefs of certification and curriculum/professional development within the Division of Curriculum and Professional Development.

Goal: Comprehensive Educational Technology Survey

Purpose: to develop and administer a comprehensive survey on the availability and uses of computers and related technologies in all K-12 schools. Information will be compiled, analyzed, and disseminated. A final report will be prepared to detail the status of educational technology in Connecticut schools.

Strategy: to establish an **Executive Council** of the Technology Advisory Council whose members will include representatives from the original membership roster and new participants, in keeping with the mission statement and originating documents. Recommendations will be made by this council to the **Joint Committee on Educational Technology** (JCET) for legislative and/or further action.

Goal: Statewide Telecommunications Network

Purpose: to link all schools (K-12), the six regional service centers, cooperating institutions of higher education, and the state department of education via a statewide audio-visual network. This telecommunications network may include, but is not limited to, the following uses:

1. broadcasting of classroom instruction from host site to receiving school districts for courses of exemplary quality, courses not available in some schools, etc.;

2. team teaching and shared classroom instruction among teachers from different school districts;

3. video-taping special programs and/or classroom instruction by schools for their resource libraries or for later reviewing;

4. providing inservice training programs, workshops, and

demonstrations over the television (live or taped) as part of our professional development efforts;

5. administrative teleconferencing;

6. encouraging schools to prepare, edit, and broadcast locally-originated video presentations;

7. broadcasting adult education programs to the community.

Strategy: to establish a **Telecommunications sub-committee** within the framework of a state Technology Advisory Council, whose membership will include representatives from school districts, Rescs, and higher education from across the state. The sub-committee will work with representatives from state government and business and industry in developing plans and proposals for implementing such a comprehensive network, with recommendations for using satellite, fiber-optic, and/or microwave telecommunications protocols. The committee will examine what other states (and the private sector) have accomplished in this area. Proposals will be given to the Executive Council for further examination, who will then make recommendations to the Joint Committee (JCET).

[Note: Although $500,000 was requested in the budget for the Telecommunications Incentive Grant, only $89,000 ($3,000 more than last year) was approved.]

Goal: K-12 Technology-Integrated Curriculum

Purpose: to develop guidelines and resource materials for a comprehensive and educationally-sound technology-integrated program of instruction for grades K through 12. Resource materials include, but are not limited to, the following:

1. a sample (proto-type) K-12 curriculum which fully integrates the use of computers and media technologies into a general curricular format that is consistent with state curriculum guidelines and educational requirements. The approach will be holistic, multidisciplinary, and of a general "scope and sequence" nature that will encourage its use as a resource guide for schools attempting to integrate computer use into the basic curriculum;

2. a revision of the state computer curriculum guide: Computers in Education: Instruction (pub. - 1985);

3. a comprehensive resource list of educational software used in Connecticut schools by subject area, grade, and skills addressed for compilation into a resource guide of software most used by Connecticut teachers;

4. reports on the issue of state site-licensing of software most used and recommended by teachers in the field as a means of providing low-cost, high-quality software to all schools.

Strategy: establish a **Curriculum Development sub-committee** under the framework of the state Technology Advisory Council whose membership will include representatives from selected school districts and higher education from across the state. The committee will examine what other states have accomplished in regard to technology-integrated curricula. Proposals will be given to the Executive Council which, upon further scrutiny, will make recommendations to the Joint Committee (JCET).

Goal: Professional Development Video Library

Purpose: to develop plans for the creation and maintenance of a videotape library of excellence in education (i.e., a showcase of excellence) that may be used by local schools in their efforts to assist teachers and administrators with professional development and skills acquisition. The professional development video library will include, but not be limited to, videotapes of the following:

1. classroom teachers recognized by peers and administrators as exemplifying excellence in teaching (note: teachers of the year are a possible beginning point);

2. exemplary programs, award-winning programs, and unique or creative programs in our schools;

3. excellence in administrative leadership;

4. tips, techniques, and tools for effective teaching (films of experienced teachers discussing and demonstrating effective instructional and management techniques for beginning teachers);

5. using computers in the classroom and in computer labs;

6. using studio facilities for class projects;

7. selected segments from workshops, seminars, conferences, and colloquia on educational technology made available to schools for inservice training programs and other needs;

8. the creation of a master video which will introduce and showcase educational excellence in Connecticut. It can be used to recruit and keep talented teachers and administrators, engender community pride in our schools and educators, and encourage continued funding and

support for educational reforms.

Strategy: to establish a **Professional Development sub-committee** within the framework of the Technology Advisory Council with representation from school districts, the Rescs, and higher education from across the state. The committee will draft criteria for selecting exemplary programs and excellent educators and will present a plan for the videotaping and editing of selected subjects (videotaping expenses to be funded through state grants), make arrangements with each RESC to house the P.D. libraries and to assist schools in making use of the library holdings, and will develop plans for the continued enhancement and expansion of the professional development video library.

Goal: Demonstration Schools and Exemplary Programs

Purpose: to identify and support schools and programs which exemplify excellence in education so they may serve as demonstration and/or training sites for educators. Grants and state assistance will encourage designated schools to develop and expand exemplary programs, develop resource materials for distribution, and work with other schools who wish to adopt these exemplary programs.

Strategy: to establish a **Demonstration Schools and Exemplary Programs sub-committee** whose membership will include representatives from school districts, Rescs, state government, and higher education. The committee will develop a list of potential demonstration-quality schools, identifying their exemplary programs and any improvements to be made prior to their designation as demonstration schools. Informational pamphlets and supporting materials detailing chosen sites will be prepared for dissemination to all schools. Incentive grants will be made available. This goal is consistent with the celebration of excellence, the report of the national task force on educational technology, and our goals of establishing model schools throughout the state. Plans will be presented to the Executive Council which will make recommendations to the Joint Committee (JCET).

Goal: State Electronic Mail System

Purpose: to encourage and expand the use of the electronic mail system as a means of expediting the flow of information and reducing delays and paper overload among all schools, RESCS, higher education institutions, and the state department of education. Enhancements and improvements to the system include:

1. establishing six 1200 baud asynchronous communications lines to replace 300 baud lines;

2. encouraging every school to purchase a modem (cost = $100-$200), communications software (cost = $100-$200), and a standard telephone line and wall jack;

3. redesigning and streamlining the system to make it easier to use, more versatile, and more functional;

4. establishing accounts for educators at every school in the state and helping users to use the E-mail system;

5. putting the Commissioner's circular letters online

6. tapping into bulletin boards around the state (CONSENSE, ACES Human Resource Bank, University of Hartford Bilingual Education Bulletin Board, etc.) to expand interlaced network of educational services;

7. putting copies of the Curriculum Guides online for schools to query and print as needs dictate;

8. tapping into e-mail systems and bulletin boards from neighboring state to foster shared communications;

9. increasing dialogue and communication between schools and the state department.

Strategy: State consultant for computers and educational technology will supervise the redesign and reprogramming of the system, in addition to providing outreach support and technical assistance, and increasing the number of users of the system. She will work with Director of Data Processing Services at the state department, users, and systems analysts from Structure Computing Systems in Farmington during the redesign phase.

Goal: Curriculum-based Resource Centers

Purpose: to serve as clearinghouses and training centers for specific areas of concentration. Resource Centers will offer: state-of-the-art technology, vast array of curriculum guides and teacher materials, workshops and training sessions, and hotline support services in the following areas:

1. Science/Math;

2. Social Studies/Foreign Language;

3. Reading/Writing/Language Arts;

4. Art/Music/Physical Education/Health;

5. Early Childhood/Special Education/Adult Education.

6. Library/Media Services; and

7. Administration/Professional Development.

Strategy: to establish resource centers (partially funded by incentive grants) at universities and colleges around the state which demonstrate sound programs, available skilled personnel, and well-conceived plans for best utilizing these resource centers to address district needs. These centers will operate in conjunction with the RESCS.

Goal: Model Schools of Educational Technology

Purpose: to establish and operate elementary, middle, and secondary schools offering model facilities, technology-integrated curricula, exemplary teaching and administrative leadership, and creative approaches to instruction. These "schools of excellence" will serve as "magnate technology-based" schools, drawing students of diverse backgrounds from the surrounding communities, and as "model technology-based" schools, inspiring educators to be creative, and enthusiastic in adapting aspects of these programs to instruction in their schools.

Strategy: to establish these schools under the auspices of universities and colleges in the state which possess strong teacher education programs, a history of leadership and participation in educational reforms, resources to support these model schools, and demonstrated excellence among their faculty in educational research, publications, and instruction.

Representative from businesses, state government, high technology firms, and higher education institutions will work together in the planning and implementation of these projects. While many scenarios are possible, the following example is offered to encourage further discussion on the subject.

Example: Model Elementary School of Educational Technology (K-6)

Number	K	1	2	3	4	5	6	Total
Classes	4	4	4	4	4	4	4	28
Students Per Class	12	17	18	18	20	20	20	
Total Per Grade	48	68	72	72	80	80	80	500

Possible Methods for Student selection:

1. Students in the top 20% of their respective classes and attending schools located in the greater metropolitan (urban/suburban) area in which the model school is located

are eligible for selection by lottery.

2. Students are selected by lottery from surrounding school districts, irrespective of class standings.

3. Students are selected on the basis of performance on CAT, mastery achievement tests, and/or qualifying entrance tests.

4. Students are selected on a stratified sampling basis, reflecting the ethnic, racial, and SES composition of the general population in that area.

Facilities: May be set up in an existing school in which physical modifications are made to accommodate the technology needs or may be specially designed and built to encourage a more futuristic environment and educational experience.

Technology Requirements: Can be any combination of the following:

a. 1 Apple Computer Lab with 20 computers, 10 printers, assorted peripherals (headsets, pen pads, mouse devices, synthesizers, etc.), and library of educational software for K-6 grades.

b. 1 IBM Computer Lab with similar holdings.

c. Classroom computers - 4 computers and 1 printer per room.

d. 1 computer projector (e.g., Limelight, Sony, Kodak, etc.) and 1 large TV monitor for large group instruction.

e. Teacher Resource Room with 4 computers and 4 printers on rolling carts, and a variety of software for creating teaching aids, etc.

f. Library/Media Center - 1 computer with hard disk drive for cataloguing and circulation of holdings (with bar wand, bar codes, database software, etc.), plus 2 computers (and 2 printers) for students and teachers to use in online searching by topic, title, or author. Modem, communications software, and a dedicated telephone line for online search and retrieval.

g. Administrative offices - 1 for principal, 1 for secretarial support functions, modem, communications software, and telephone line access for using electronic mail systems and other online bulletin boards, suitable software.

h. Or 1 computer per child in each class (Papert's dream) with 1 printer for every four computers and available software and peripherals for computer-based instruction in the classroom.

Costs: using existing schools - roughly $2.5 million
building new schools - roughly $5-6 million.

Funding: Some possibilities are listed below.

1. Computer companies may donate some of the hardware and software needed, or offer substantial discounts to place their products in such a unique educational setting.

2. Leading businesses and industries may underwrite some of the costs because of the innovative appeal of the project.

3. State funds may be allocated to set up these magnate schools.

4. The sponsoring university or college will contribute some funds and resources to the school.

These model schools have the potential for generating much excitement, interest, and support in the public and private sectors. They can spur other school systems in the state to strive for excellence and integration in using technology.

Goal: Higher Education Teacher Preparation Programs

Purpose: to modify and enhance current courses in teacher preparation programs at the university and college level to include instruction in the uses of computers and related technologies in education today. Few postsecondary teacher education programs have incorporated educational technology into their curricula, with the result that beginning teachers possess little formal training in the instructional use of computers and educational media and must acquire these skills in the classroom.

Strategy: to work with the Department of Higher Education and representatives from various Teacher Education programs in Connecticut institutes of higher education in revising current teacher education courses to include instruction in using and integrating educational technologies in classrooms and lab settings. Pilot tests of these experimental programs will offer insight into the practicality and feasibility of making such modifications throughout the state in teacher education programs, both undergraduate and graduate. Similar modifications and pilot tests can then be undertaken for programs training educational administrators, computer coordinators, and library/media specialists.

Goal: National Educational Technology Support Network

Purpose: to form a national support network among state department officials principally involved in issues of educational technology and its impact on education. This national

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association will prove instrumental in promoting the sharing of information and resources across state lines (e.g., satellite linkups between schools). In addition, such an organization could begin to impact national policies and legislation on educational technology, and set the tone for a nationwide effort to revitalize and revamp the educational system in keeping with our step into the twenty-first century.

Such an organization could also assist in establishing liaisons with educational systems in other countries (i.e., Canada, Mexico, Wesern European nations, England, etc.) as a means of promoting cultural awareness and respect and building bridges that may contribute to knowledge, friendship, and understanding in the educational community.

Strategy: to encourage the Connecticut state department of education to take the lead in establishing a national association of state educational techology consultants (NASETC) and to host the first meeting of this group in Hartford in 1988.

Conclusion

The ideas and plans contained within this proposal are bold, innovative, and sweeping. If we work together and concentrate our energies and resources on these goals, we can achieve every one of them within the next decade.

We, the Leaders of Today, are the Architects of Tomorrow.

Senator LAUTENBERG. Excellent.

We will finally give Mr. Bernhard, the teacher, a chance to talk about some of the things that they are doing. We look forward to hearing this.

Mr. BERNHARD. Good morning. I am an elementary school teacher, for the last 9 years at Bernard Brown School in Hartford. That is my primary function there.

I have been working with one of Mr. Barstow's programs for the last 5 years in teaching computer education. Primarily I teach Logo, which is a computer language, geared primarily for the elementary-middle school student, but we have been able to do a lot with it with elementary school.

Now, what I've seen is how children blossom and how they grow and how—just with excitement. Now, we're talking about a young student, maybe in third grade, fourth grade, with limited skills, basically about angles, measurements, and what they've been able to do is transfer some skills taught in the classroom to skills on the computer, able to see how you make an angle, how it looks, with this computer graphics, which I am sure we'll see later with another demonstration.

Another thing we've been working on in Hartford, and that's outside the school system, is a computer camp. I'm not going to really go into it, but I've been in charge of a computer camp at the Hartford Graduate Center for the last 4 years.

We've been able to service approximately 200 students, but it's a limited funded program. Primarily, we're teaching Logo and, once again, we've been able to see the success at the camp and the success at the after-school program and, hopefully, being transferred over into the regular classroom. So I really do think that this bill that was proposed is quite important, and I would hope it would go through.

Senator LAUTENBERG. Thank you very much.

Hartford is a wonderful community. I think I know it fairly well. If you've ever heard of a company called ADP, Automatic Data Processing, it's a company I started lots of years ago with a couple of other fellows. We have several locations in the State of Connecticut.

I know that the quality of education at the higher level in Hartford is perhaps second only to maybe Boston. You have Wesleyan there and Trinity, I believe, and you have, of course, the University of Hartford, which is ever expanding, and Mr. Tractenberg, if you know who he is, is a very good friend of mine.

The students that you brought with you today make a very impressive case, I must tell you. My compliments to both of you.

Leticia, I look forward to seeing your works published. You have an unusual talent, and we're pleased that the computer meant so much to you.

And you, Juan, as we listed to you describe the things that you're learning, including logo, et cetera. It's a very, very important lesson for us. And you're here before the U.S. Senate—that's pretty lofty. I didn't get here until I was a lot older than you. So you've got a good start.

As a matter of fact, I testified in 1970 before a Banking Committee on having something to do with computers. And as I look at

that testimony now, it was terrible, and yours was much more interesting, I can assure you. I thank you very much.

One of the regrets that we have is that this record isn't portrayed, somehow or other, synthesized for video, because the nuances are not reflected in the typed word, and it's too bad because there's a degree of persona, emotion that is involved with these students as they do these things. It's very, very important because it just doesn't build learning; it also builds character, it also builds participation, and I think that's a critical part of this. You just don't get that in the written word.

But we will push very hard on this legislation. You've given us additional impetus, and we see the value of it. I knew that before I introduced the legislation. But now that you've confirmed it, it's going to help the cause. We thank you very much for being with us.

The next panel is Ms. Angela Caruso, Pamela Morgan, Julissa Vizcaino, Anthony Baker, Tony Silva, students in Newark, from Newark, and educators from Newark, New Jersey.

I have a particular interest in that community since I serve the State of New Jersey.

Welcome. We are pleased to see you here. Newark is where I have my headquarters for my State operation. Newark is our State's largest city. It also has some of our State's largest problems. It has some of our State's largest opportunities, in my view. The opportunity lies in making sure that the young people have the tools with which to move on into life, and I am pleased to have you here and testifying on this bill.

I would ask you, Ms. Caruso, if you would begin, remembering the clock is running. Try to consolidate your testimony; we're interested in hearing from you. Please go ahead.

STATEMENTS OF ANGELA CARUSO, DIRECTOR, COMPUTER EDUCATION AND TECHNOLOGY, NEWARK SCHOOL DISTRICT, NEWARK, NJ; PAMELA MORGAN, TEACHER, ALEXANDER STREET SCHOOL, NEWARK, NJ; JULISSA VIZCAINO, STUDENT, NEWARK, NJ; ANTHONY BAKER, STUDENT, NEWARK, NJ; TONY SILVA, STUDENT, NEWARK, NJ

Ms. CARUSO. Thank you, Senator Lautenberg.

As an educator and as the director of computer education for the Newark School District, it is really a pleasure for me to be here this morning, and to be able to talk about something that is very important to me—computers and children.

There is no doubt that computers have become very important in our everyday life. And, as has been stated before, computers and information technology are radically changing the shape of everything we do in all facets of our everyday life: business, industry, government, medicine, and certainly in education.

It is our responsibility, as educators, to prepare our students to meet the challenges of this Information Age. We must prepare them to succeed in a technologically advanced work place and in a society where computers are part of what they will be doing.

Computers were used in Newark very early but around the year 1980, when the microcomputer became very important, we realized

that we had a challenge in front of us, and that was to be able to bring computers into the classroom, with very limited resources.

As you've mentioned, Senator Lautenberg, Newark is a very large district. We have approximately 53,000 students attending over 80 schools. We provide education for all of our students in a variety of ways with very many programs. Our school district certainly has all of the problems that are evident in every large urban city. But we also have many positive programs that are affording our children the best that we can possibly give to them in education.

Many studies have shown that children in large urban areas, less affluent areas, have traditionally used the computer for drill and practice, where students in more affluent areas have learned to program or have used the computer as a tool.

In Newark, in order to ensure equal access, not only to the computer hardware but to the way computers are used, we developed an implementation plan that included not only acquisition of hardware and software, but also concerns about wiring, maintenance, installation and, most important, teacher training and support to help integrate our computers into the classroom.

The emphasis on the use of computers in our district has been to integrate the computers into the content areas, and to realize the potential of the computer as a tool. We hope that our students will be able to use the computers to solve problems, to gather information, to understand and use that information in a variety of ways.

We use the computers in English classes to write; we use data base technology in our social studies classes. Computers are used for computer-aided design in our vocational ed classes. There are many, many programs and many needs that the computer can help us to meet.

We have seen many students who are low achievers become high achievers in a computer lab, and students who are not interested in staying in school have found some motivation in using the computer to remain in school. Others have learned skills that have helped them in their careers.

We need your help in order to continue to provide these programs to our students, not only to provide the hardware and the software, but I feel I must emphasize again how important it is to have properly trained teachers who feel comfortable with the computer, can select the appropriate hardware and software, and then can use that computer effectively in an educational setting.

If it is true that education is the drive-wheel of an informed society, then it is essential that all of our people be given the opportunity to learn to participate in that society.

I would like to thank you for all of your support in the past, and particularly with this bill. I feel that it shows a great understanding of our needs, and especially in urban areas.

I am very happy today to be able to come here and talk before you, and happier to be able to bring with me one of our teachers and three of our students. Thank you.

Senator LAUTENBERG. Thank you very much, Ms. Caruso.

[The prepared statement of Ms. Caruso follows:]

Senate Subcommittee Education, Arts and Humanities
S. 838, Computer Education Assistance Act

Angela Caruso, Director
Computer Education and Technology
Newark, New Jersey School District

Computers have become part of our everyday life. There is no doubt that computers and information technology are radically changing the shape of everything we do in all facets of our lives- business, industry, government, medicine, entertainment and education. It is our responsibility as educators to prepare our students to meet the challenges of this information age. We must prepare them to succeed in a technologically advanced workplace and in a society where computers and the information they provide are a vital component.

Microcomputers began infiltrating education in 1980 - 81. The use of computers began as a "grass roots movement" initiated by parents and teachers. At that time, the Newark School District realized the need to bring computers into the classroom but also realized that resources were very limited and computers were very expensive.

As you know, Newark is a large urban district of approximately 53,000 students attending over 80 schools.

Our school district has all the problems that are evident in every large urban city. One of our primary concerns was the need to provide equal access to computers for everyone. But just having computers was not enough. Our students need to have equal access to the way computers are used. Many surveys have shown that in less affluent, larger urban districts computers have been primarily used for drill and practice. Students in more affluent areas were learning to program and to use computers as tools.

To insure equal access to as well as implement programs that used computers in many ways, not just as electronic workbooks, an implementation plan was developed in the district. This plan has been modified many times but the following components have always been included:

(1) acquisition of hardware and appropriate software;

(2) wiring, installation, room security, maintenance and insurance;

(3) teacher training; and

(4) support to help integrate the computers into the classroom.

In Newark, the emphasis on computer use has been to integrate the computer into the content areas and to realize the potential of the computer as a tool and a valuable assistant Students can use the computer to write programs and to reinforce basic skills but they must also be able to use it as a tool to help them solve problems, gather information, understand and use that information as well as to learn higher order skills. For example, in social studies classes, students gather information, collect it on a database and use that information in a variety of ways to draw conclusions, make comparisons and evaluate data.

In English classes students write more freely using word processors. Art students learn to create graphics and science students simulate experiments that could not be conducted in a classroom.

By using the computer as a tool, the students are not only learning content area skills but are also learning to control the computer and understand how it can help them.

We have seen students who are low-achievers become high achievers in the computer room. For many students, the computer provides the motivation they need to stay in school. Others are learning skills that can be used in careers.

Schools need help in order to be able to provide programs for all students, and to have enough hardware and software to maintain the equipment and most of all to train teachers so they will be able to select appropriate computer applications and use them effectively in their classrooms.

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If it is true that education is the drivewheel of an informed society, then it is essential that all people be given the opportunity to learn to participate in that society.

Today, three students from the Newark School District, Julissa Vizcaino, Anthony Baker and Tony Silva, and a computer teacher, Pamela Morgan, will demonstrate some of the projects they have developed. Although they have had limited access to computers during the year, the skills they learned in that short time can be seen in their projects.

(Note: In the interest of economy, the demonstration graphs accompanying this statement were retained in the files of the committee.)

Senator LAUTENBERG. Ms. Morgan, we are glad to have you here, and I invite you to give your comments.

Ms. MORGAN. Good morning, Senator Lautenberg. Thank you for giving me the honor of appearing here before you this morning.

I appear before you as an advocate of computer education. I have been an educator in the Newark school system for the last 16 years. During that time, I have witnessed many programs that were hailed as being the remedy for why Johnny couldn't read, write or do arithmetic. I cannot recall one program that has gained my respect as the Computer Education Program has.

My interest in computer education was piqued when my own children came home so very enthusiastic about their school's Computer Education Program. I began to investigate methods to use computers educationally, and became very impressed with my findings. That was the beginning of my association with computer education.

I feel particularly fortunate to work in a district where we are encouraged to use computers as tools to enhance learning. In our district, under the direction of Ms. Caruso, we have computer programs for the deaf and fine arts students in addition to the programs for the regular academic curriculum. Much planning has taken place to ensure that the computers are used in a variety of educationally credible ways, not solely drill and practice.

In my own school, I have initiated several programs. We use the word processor as a tool to teach writing and literature appreciation. We have done writing projects aligned to the New Jersey State High School Proficiency Test and have developed primary level poetry/prose projects.

Additionally, some of my children use the word processor to write the script, including commercials, for their own entertainment show, The Alexander Street Today Show, which was taped for viewing by the student body.

We also teach the logo programming language. I feel that logo was selected for our use because it represents a total educational philosophy based on Piajet's theory of learning. We are able to tie logo in to all areas of our curriculum. In my logo classes, I give particular attention to problem-solving, which was named by the Math Teachers Association as the problem of the year. I have found working in a computer lab to be a unique experience.

As can be expected, behavior of the pupils is excellent. Part of the cause can be attributed to the fact that because computer education is relatively new, the pupils are excited. However, I have witnessed that even when the newness has worn off and the work becomes difficult, the general attitude of the pupils remains the same.

It has been quite interesting for me to observe pupils who have never met with success previously, twice-retained students, chronic truants, et cetera, who have come into the lab and who have become highly motivated pupils. I have seen gifted learning disabled students, those with high intellect who have had difficult previously conforming to school diction, I have seen them come into the computer lab and, for the first time in their lives, begin to work up to their true potential.

I truly believe in the value of computers in education. My experience has shown that the computer is a tool that offers another important mode of learning for our youth. In this TV age, it is maybe easier for the pupils to relate to the computer screen than to the flesh and blood person who is attempting to educate them.

I believe we have a responsibility to expose our children to and to provide our children with the tools that will enable them to meet the challenge of the twenty-first century. Certainly, by supporting the bill, S. 838, which is currently under consideration, we can live up to our responsibility.

I would now like to introduce some of our students, Julissa Vizcaino, Tony Silva and Anthony Baker, who will demonstrate some of the computer activities in which they have participated.

Senator LAUTENBERG. Thank you. That's excellent.

I would advise Ms. Vizcaino to put her little name plate out in front so we can see who she is. The boys managed to get those names out there. We want to make sure that we all know who you are. We invite you to do it, and speak up into the microphone. We are very interested.

Ms. VIZCAINO. Thank you.

I would first like to demonstrate a logo graphic file of the U.S. flag. The border of the flag, as you will see on the screen, is an ordinary rectangle, therefore, a primitive command such as "Repeat FD," which stands for "forward" in logo, and different degrees of right angles were used to make the border. The stars and colors are a little more complicated and required more time and skill, but with a little dedication and a few mistakes, I was able to finish it.

Senator LAUTENBERG. We are able to see that on this TV monitor here. I'm sorry that that's not plain for the audience. That's excellent.

Ms. VIZCIANO. You are about to see how the suffixer works, using the suffixes "er" and "iest." The program can be used to improve knowledge of language suffixes, and of rules of adding suffixes.

The program BRAG demonstrates how the suffix "er" can be added to a word, while the program BOAST demonstrates how the suffixes "ier, iest" can be added to a word that ends in "y." SUPER BRAG, which is more complicated, is able to choose between BRAG and BOAST to add the correct suffix to a word.

Thank you.

Senator LAUTENBERG. Very good. You had better switch your name plates up here, we don't want to get anybody mixed up.

Mr. SILVA. OK. My logo project is a design of a bookcase. I decided to make the bookcase because I work with my uncle who is a cabinet maker. This project is like some of the things we make.

Senator LAUTENBERG. You did the design here, Tony?

Mr. SILVA. Yes.

Senator LAUTENBERG. That's very good.

Mr. SILVA. That's it.

Senator LAUTENBERG. Did your uncle use this as a model for something that he was going to make?

Mr. SILVA. No. This was my idea.

Senator LAUTENBERG. This was your idea. Now you've got to get him to build it. Very good.

Mr. SILVA. Thank you.

Senator LAUTENBERG. OK. Here we go. We're really testing to see whether you remember who you are here. OK.

Mr. BAKER. I would first like to demonstrate a Logo graphics file of—excuse me.

Senator LAUTENBERG. The shifting of the chairs got them mixed up. The same thing would happen to me, I can tell you.

Mr. BAKER. I would first like to demonstrate a Logo graphics file called Moon. As you look at the screen, you can see what resembles the Earth and a U.S. space shuttle on the moon. You can also see the screen changing colors and the many stars appearing in the different colors at various points on the screen.

The graphics that you see here are made up of a group of procedures, programmed in logo. In addition, it takes plenty of careful planning to get the procedures to work together smoothly.

Senator LAUTENBERG. Did you do the coloring, as well, in the program?

Mr. BAKER. Yes.

I would now like to present another computer exhibit to you. Graphing assistant has been used to incorporate computers into social studies curriculum. By using graphs in conjunction with the word processor, it enables you to produce reports that contain graphs.

I looked in the Almanac and found the statistics on the casualties in the Korean and Vietnam wars. I used Graphing Assistant to help me analyze the statistics. I will now demonstrate how the graph works.

Senator LAUTENBERG. You're addressing the file that you've got keyed into——

Mr. BAKER. Yes. I have the file name.

We can clearly see that during the Vietnam war, the Army, Navy and Marines lost more men than they had during the Korean war. Although the Air Force used 455,000 more men during the Vietnam war than they did during the Korean war, they had 4,017 less casualties during the Vietnam war.

Thank you.

Senator LAUTENBERG. Very, very good. Thank you.

I think what we saw was a variety of uses that we can get out of a computer and programming. The thing that's so striking is that the students have figured out their own ways of demonstrating a skill that they've developed. It's very interesting to see that when you add a tool like this, that you can change the structure of educational programming.

I'm familiar with a program that took place in Newark. I met a teacher and a school principal. We had a meeting at Weequahick High School with some of the educators one time and found that a young child, first or second grade, who had tough behavioral problems, actually modified his behavior when he was introduced to the computer, when he had the opportunity to do something that was creative on his own, in which he could develop things at his own pace.

It really told me a lot more—and I know something about computers—about what we might expect from appropriate computer access. Not only does it invite a challenge in thinking, but it also encourages the pace to be different among students, that helps get

them to their maximum ability, and it's a wonderful, wonderful assist.

I wonder, Ms. Caruso, whether you could tell me this. Are you familiar, by any chance, with the income statistics in the city of Newark?

Ms. CARUSO. Actually, I couldn't quote any statistics for you. I know that almost all of our schools, with the exception of a very few, are in what is called a Chapter One Attendance Area which rates their socioeconomic level and income level, so I know that the level is low.

Senator LAUTENBERG. On an economic yardstick, I think it is important that we understand that Newark is one of the more troubled—let me modify that—the most troubled city in the country.

Now, I remember Newark when it had its fair share of well-paid taxpayers and educational spending was—very, very good, and now it has been disadvantaged by the lack of funding and the lack of, frankly, interest on the part of so many people outside the city. And we cannot ignore the Newarks of our country and expect us to be a whole society.

I'd like to ask, Ms. Caruso, what's your ratio of students to computers in Newark?

Ms. CARUSO. Right now we have approximately 50 computers for every student—no, 50 students for every computer. It was wonderful the other way. I know that is significantly less than the national average.

Senator LAUTENBERG. Mind you, one computer for every 50 students. Now I think there is a chart up there that was put up, the first chart, that tells you what the ratios are—remember that figure, 50 to 1—how much time can each student spend working on a computer? Can they work with it each day, less frequently?

Ms. CARUSO. What we have done to try to make their computer time most effective is to have the students scheduled into a computer lab for semesters. So these children have had the opportunity to work on the computer for 6 weeks out of the entire school year.

Senator LAUTENBERG. How much time?

Ms. CARUSO. Approximately 6 to 8 weeks. It varies in every school; 6 to 8 weeks during the year, of access to computers on a daily basis.

Senator LAUTENBERG. Now, 6 to 8 weeks; and how much time would you say——

Ms. CARUSO. That would be a 45-minute period every day, or in some schools it's every other day, depending on the population. So their access is limited.

Senator LAUTENBERG. The access is limited. You're talking about 45 minutes a day over a 6-week period.

Now I'll tell you, we don't be able to find the appropriate chart, or maybe I'm not reading it properly, student access to computers—well, computers per 30 students. So if we look at 1985, let's say 1986, the easiest line to work with, we take elementary schools, the blue line, there is approximately 6-tenths of a computer for every 30 students. Now, that is the average across the country.

If we have to convert to the Newark ratio, we get something like two-tenths, more or less, where we have to convert 50 to 30, around

one and a half, 1.5 or fifteenth-hundredths. It's not a good ratio. It's way below the national average.

As a matter of fact, we find that in places like California, we have 20 to 30 students to a single computer. Texas, mid-Atlantic, New Jersey, including New Jersey and New England, 31 to 40 students per computer. In Newark, we have 50 students per computer.

What would you consider an optimum number, Ms. Caruso? There's the perfect example. The green, or whatever that last color is, is among the worst, and you see—it looks like two states that are in that category, one state that has more than 60 students per computer, and we include in New Jersey, 31 to 40 students per computer, with the exception of Newark which has 50.

I can tell you, my birthplace, Paterson, has a very poor ratio. I can tell you that Camden has a very poor ratio. And we have affluent suburbs, because New Jersey is the second highest per capita income state in the whole of the United States, and lots of computers in those areas. The kids have them at home, they have them in schools, they're all over the place. They have them in libraries. There's a lot different access. What we are seeing is the disparity in the educational level just continuing to enlarge. Bad news.

What would you consider, would you say, an optimum number of students per computer?

Ms. CARUSO. Well, I think I'm not going to limit myself to a number. What I envision is certainly having enough computers in the schools so that every student would have access to computers every day.

I feel that it is tragic that these students can only get to work on the computer for 6 weeks and produce the kind of projects that they do. So I think if we had a few labs in every school, and I guess that would be approximately 15 computers in a lab or 25 computers in a lab, and had at least two or three of these in a school, it would give us the flexibility of having students go in at different times during the day for different periods of time.

Senator LAUTENBERG. Do you have a couple of high schools in Newark that take the students most likely to be going to college? What are those?

Ms. CARUSO. We have three magnet schools. We have University High School, we have Science High School, and then we have Arts High School.

Senator LAUTENBERG. Do most of the students come, let's say, to University High School from the Alexander Street School?

Ms. CARUSO. Well, I think that the two students that we have here today will be going to University High School, Julissa and Anthony.

Senator LAUTENBERG. Do you think that there's a coincidence that their interest in computers has helped them achieve enough to get into this very advanced high school with its curriculum?

Ms. CARUSO. I think maybe Mrs. Morgan, their teacher, might be able to answer that a little better. I know I've seen it, and I've heard from her, but I think she might like to respond to that.

Ms. MORGAN. I think the work that they have done with the computers have given them another thought process that has helped them to achieve. Even though we have short periods, the work is intense and they have done very well.

Senator LAUTENBERG. And they've responded to the opportunity that the computer presents them; right?

Ms. MORGAN. That's right.

Senator LAUTENBERG. Because I think it is fair, isn't it, Ms. Morgan, to say that for many students in your school that home life is difficult because of income levels, things of that nature and, as a consequence, the student doesn't always get the same encouragement for learning that we would like to see, and here's an opportunity to kind of get around the problem that exists for so many. Is that a fair thing to say?

Ms. MORGAN. I think it is.

Senator LAUTENBERG. Newark, Ms. Caruso, has been ahead of other districts in preparing a plan for computer education. You've had several years experience. What advice would you give other districts, just starting to plan?

Ms. CARUSO. Well, I think that what has happened to us is that it was absolutely essential to develop a plan that included all the components that we feel are important. It is not important enough to just buy hardware. But before you buy that hardware, we have each of the schools interested in starting a computer program develop an educational plan.

We feel that it is essential for the principal and the teachers involved to decide what they want to do, educationally, with the computer. That educational plan is submitted to my office, and then we work with the school to help them acquire the appropriate hardware and software to implement their educational objectives.

I think that that is essential, that the most important thing is not just putting 50 computers in the school, but certainly to have a plan to use those computers. Along with that, there are many, many expenses and many areas that have to be considered.

One of them is the money that we have to use to wire a lab. It costs us approximately $1,500 to wire every computer lab. We must maintain security, or our computers will be gone and there's no replacement. We must have maintenance available—computers aren't very effective if they don't work. And I think that the most important area is the area of teacher training. We try to provide as much training as we can for our teachers, and then to provide them with ongoing support.

So I think the plan must be based on educational objectives and must include all of those components, and must be flexible because it changes very frequently.

Senator LAUTENBERG. Good advice.

Ms. Morgan, what advice would you give to a teacher? I was struck by the way that you said you came upon an interest in computers, developed within your own family; right?

Ms. MORGAN. Right.

Senator LAUTENBERG. What advice would you give to a teacher just starting to use computers in the classroom? Is there something that you would like to offer by way of experience that you think would help?

Ms. MORGAN. You must fully immerse yourself into the study——

Senator LAUTENBERG. We are going to have to hear you, the words are too good. You can't be shy around here, I can tell you.

Ms. MORGAN. All right. You must make a total commitment to your job as a computer teacher because it will take a tremendous amount of time to train properly, to do the job.

Senator LAUTENBERG. Get in it with both feet, is what you're saying?

Ms. MORGAN. That's right.

Senator LAUTENBERG. Last question. Do you have an idea what you think might be optimum use of computers in a classroom, numbers? How much time would you like to see youngsters have available on computers?

Ms. MORGAN. I would like to see the pupils come every day for the entire school year.

Senator LAUTENBERG. Computers available each day?

Ms. MORGAN. That's right.

Senator LAUTENBERG. We thank you both, and we thank the students very much for being with us.

I want to point out that your full testimony, your full statement, will be included in the record, and that's true for you as well, Ms. Morgan, if you have a statement that you want to submit.

We thank our young people and encourage them to go forward, to go on with their education, because the Senator that's talking to you right now grew up in a time and in a family where income was also a very, very serious problem. I just kept working hard and kept learning and, finally, things began to open up.

And I was early in the computer business—not because I was so smart, but because I was there ready to take advantage of an opportunity that fell in my way. So I encourage each one of you to continue with your education, continue learning. Thank you very much.

The next panel I would like to call would be to combine both remaining panels and, therefore, we would ask Dr. Roberts, Mr. Tucker, Dr. Becker, Ms. Dickerson and Ms. Monahan to join us and to give your testimony, limiting it to five minutes.

What I am going to do, I'll again remind you, that same ominous reminder, that the clock is watching, that we will take your full testimony into the record, we'll ask that you submit it. We'll ask for you, please, to summarize what you have to say.

Unless you are aware of an order different than the one I have, I'll ask Dr. Roberts to start, then Mr. Tucker, Dr. Becker, Ms. Dickerson, Ms. Monahan, in that order.

STATEMENTS OF DR. LINDA ROBERTS, PROJECT DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT STUDY ON EDUCATIONAL TECHNOLOGY: AN ASSESSMENT OF PRACTICE AND POTENTIAL, WASHINGTON, DC; MARC S. TUCKER, EXECUTIVE DIRECTOR, CARNEGIE FORUM ON EDUCATION AND THE ECONOMY, WASHINGTON, DC; DR. HENRY JAY BECKER, RESEARCH SCIENTIST, CENTER FOR SOCIAL ORGANIZATION OF SCHOOLS AND CENTER FOR RESEARCH ON ELEMENTARY AND MIDDLE SCHOOLS, THE JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD; THELMA DICKERSON, MEMBER, BOARD OF EDUCATION, HARTFORD, CT, ON BEHALF OF THE NATIONAL SCHOOL BOARDS ASSOCIATION; MARILYN MONAHAN, PRESIDENT, NEA-NEW HAMPSHIRE, ON BEHALF OF THE NATIONAL EDUCATION ASSOCIATION

Dr. ROBERTS. Thank you very much, Senator Lautenberg. It is, indeed, a pleasure to testify at this hearing this morning.

I am currently directing the OTA study on educational technology, and we are very gratified and pleased that you have been able to use data from our interim report "Trends and Status of Computers in Schools: Use in Chapter I Programs and Use With Limited English Proficient Students" which was delivered to the Congress in March. As you know, that report looked at major changes in computer demographics, and focused specifically on the uses of computers in Chapter 1 programs and programs for limited English proficient students.

OTA has also produced a 20-minute video tape based on site visits we made to classrooms around the country, where we saw promising and diverse uses of the technology in classrooms. We are continuing work on the educational technology assessment, and expect to complete our final report in spring of 1988.

Let me briefly summarize three major findings from our preliminary work. First, most schools have at least some computers. However, few schools have sufficient resources—handware, software, and trained teachers—to take full advantage of the benefits that computers can bring to the learning process.

Second, the use of computers now extends into all areas of the curriculum, but this has happened in record time. The newness makes evaluation difficult. We lack systematic research on its effects on learners, on the curriculum, and on the instructional process. However, anecdotal evidence from the classrooms where computers are being used and used well—as we've seen demonstrated this morning—indicates that in addition to the benefits of self-paced drill and practice, there may be improvements in student motivation, enhanced resources for learning and understanding traditional subject matter, and expanded opportunities for those with special needs.

Third, while introducing computers is relatively easy, developing the proper infrastructure to realize their full potential is far more difficult to accomplish.

It is clear that the application of technology in schools is an innovation in transition. We see changes occurring that are the result of learning from current experiences in a variety of classroom settings and research and experimentation in progress. We

know that this transition creates uncertainty, but it also offers new opportunities.

We think that OTA's work can help define strategies for better use of computers in education, which is the basis of the legislation that is now before the Committee.

Let me just very, very briefly highlight a few points. There are more computers now in the nation's schools than there were in 1980, but there are still barely enough to go around.

The point I would like to emphasize is that given the choice between a widespread distribution of the technology to as many schools as possible or a more concentrated and coordinated distribution of hardware and software to user groups with particular needs, school districts have generally favored broad diffusion.

In the future, school districts are going to have to decide whether to continue this pattern or to focus their resources.

As shown in OTA's analysis—figures which were highlighted by Senator Dodd this morning—there were striking differences in access when schools were first acquiring computers. Students in wealthier schools and school districts had greater access than did their peers in poorer districts.

Many of these differences have been reduced and, in some cases, have even disappeared at the high school level. But we know that in individual classrooms and in schools across the country, there are still tremendous differences. Numerous factors influence the availability of computer resources.

One factor has been the use of Chapter 1 funds to increase the resources that are available. Some districts have used these funds to purchase hardware specifically to increase disadvantaged students' access to computers. Another approach some districts have taken is to acquire specific comprehensive computer-assisted instruction systems that meet the special needs of these students. But there are many variations in use and effectiveness.

Notions of how computers can be used in the classroom are changing rapidly as a result of what can only be characterized as an ongoing experiment.

The scope and quality of software also varies tremendously, and OTA found that there are limited software materials in some areas of the curriculum. For example, students with limited English proficiency are often—more often than not—last in line to use computers. And while the reasons for limited use with these students are many and complex, the lack of appropriate software applications clearly contributes to the problem.

Senator LAUTENBERG. Ms. Roberts, I hate to do this to you, but I'll then have to administer the same fair-handed justice to everybody else, but I would, therefore, ask you to conclude your statement at this point.

We have a full text, and I've been following your testimony. It's excellent and interesting. I assume that the video tape is also being submitted as evidence.

Dr. ROBERTS. Yes, it is, sir.

Senator LAUTENBERG. We appreciate it very much.

Dr. ROBERTS. Thank you.

[The prepared statement of Dr. Linda Roberts follows:]

STATEMENT OF LINDA G. ROBERTS

Good morning. It is a pleasure to testify at this hearing on the Computer Education Assistance Act of 1987 (S. 838). I am currently directing an OTA study entitled, Educational Technology: An Assessment of Practice and Potential. In June 1986, the House Committee on Education and Labor asked OTA to examine the uses and effects of computer-based technologies in elementary and secondary schools. As part of the assessment, OTA prepared a Staff Paper in March on the Trends and Status of Computers in Schools: Use in Chapter 1 Programs and Use with Limited English Proficient Students. OTA also produced a 20 minute videotape that examines the promise of new educational technology as found at six sites in the United States. Today I will summarize key findings from our preliminary work that lead into the issues that will be covered in the Final Report, to be completed Spring of 1988.

First, most schools have at least some computers, which are primarily being used as tools for learning, and not as objects to be studied. However, few schools have sufficient resources (hardware, software, and trained teachers) to take full advantage of the benefits computers can bring to the learning process.

Second, the use of computers now extends into all areas of the curriculum, but this has happened only in the last few years. The newness makes evaluation difficult; we lack systematic research on its effects on learners and on the instructional process. However, anecdotal evidence from the classrooms where computer-based technology has worked well indicates that in addition to the benefits of self-paced drill and practice there may be improvements in student motivation and expanded opportunities for those with special needs.

Third, while introducing computers is relatively easy, developing the proper infrastructure to realize their full potential is far more difficult to accomplish.

It is clear from these findings that the application of computer-based technology in the schools is an innovation in transition. Changes are occurring as a result of learning from current experience in a variety of classroom and experimental settings, and from continuing technological development that offers new uses. This transition creates uncertainty, but also affords opportunity for planning the next steps to take. OTA's findings can help define strategies for better use of computers in education — which is the basis for the legislation that is now before the Committee. Let me focus briefly on each of these findings in turn.

Spread of Computer Use

Close to 2 million computers are now in the Nation's schools, the majority of which are in public schools. While only 26 percent of schools had any computers for instruction in 1980, virtually all elementary and secondary public schools have them today. But this does not mean that students have ready access to computers. The number of computers per 30 students — the size of a typical classroom — has increased since 1983. (See Figure 1, Student Access to Computers, 1983-1986.) But there is still barely one computer per 30 students.

Access to computers has improved because of investments in hardware. To date, given the choice between a widespread distribution of the technology to as many schools as possible, or more coordinated and concentrated distribution of specific hardware and software to user groups with particular needs, school districts nationwide have generally favored broad diffusion. In the future, school districts will have to decide whether to continue this pattern or to focus their resources.

When schools were first acquiring computers, striking differences in access were found. Elementary, junior, and senior high school students in wealthier schools and school districts had greater access to computers than did their peers in poorer districts.

These differences have been greatly reduced and have even disappeared at the high school level. The pattern of computer access also varies considerably from State to State. (See Figure 2, Cross-State Differences in Average Number of Students Per Computer, 1986.) In some States students with low socioeconomic status have equal or even superior access to computers.

Numerous factors influence the availability of computer resources. These include: local district funding, State support, availability of Federal funds, public/private partnerships, and support from PTAs and other parent groups. Chapter 1 funds appear to have increased the resources that are available. Some districts have used Chapter 1 funds to purchase hardware specifically to increase disadvantaged students' access to computers. Another approach has been to acquire specific comprehensive computer-assisted instruction systems that meet the special needs of these students.

Variations in Use and Effectiveness

Notions of how computers can be used in the classroom are changing rapidly, as a result of the ongoing "experiment." For example, the early emphasis on computer programming and computer literacy has shifted; instead emphasis is growing on using the computer as a tool for learning in many curriculum areas. One reason for this is the development of software for almost all subjects and the application of general information handling tools, such as word processors, database managers, and graphics systems that are valuable in a number of content areas.

The scope and quality of software that have been developed vary widely. Since the effective use of the computer depends directly on the software, the scope and quality of available materials can enhance or limit the use of the computer. For example, there are currently few software packages to teach English as a Second Language (ESL). OTA

found that only one in five ESL teachers uses computers with their students. While the reasons for limited use of computers with these students are many and complex, the lack of software applications in languages other than English clearly contributes to the problem.

Whether teachers are adequately trained for instructional applications of computers also creates variations in effectiveness of use of computers. There is no quick and easy way to provide the training teachers need. As development of more "user friendly" computer systems continues, along with increased use of content-related software, or the addition of new skills and learning opportunities, teachers will need a different kind of training. The issue of continuing teacher training and support is the one factor most frequently mentioned by educators, computer manufacturers, and software developers as the most important ingredient to effective implementation of new technologies.

It is too early for definitive pronouncements on the effects of computers in education; however, we can learn much from the classrooms where computer-based technology has worked well. Teachers report that computers can raise student enthusiasm and interest in subjects where they are used, and enhance cooperative learning as students work together on projects at the computer. The computer can provide special opportunities for academically gifted students, as well as make it possible to open doors to learning previously closed to students with special needs or physical handicaps. Traditional classroom subjects such as history and social studies can be enhanced through the use of student created or managed databases, or simulations of historical events.

In the special case of Chapter 1 and programs for students with limited English proficiency (two program areas that OTA has examined), there is a general belief among practitioners and researchers that computer technology enhances motivation and increases opportunities for learning. Some Chapter 1 programs using technology report

marked improvement in achievement in mathematics and reading through computer drill and practice and other applications such as word processing and problem-solving software. Use of computers for writing and long-distance networking show particularly promising results in developing the written communication skills of limited English proficient students, while advances in speech processing technologies can enhance oral language learning and English speaking skills.

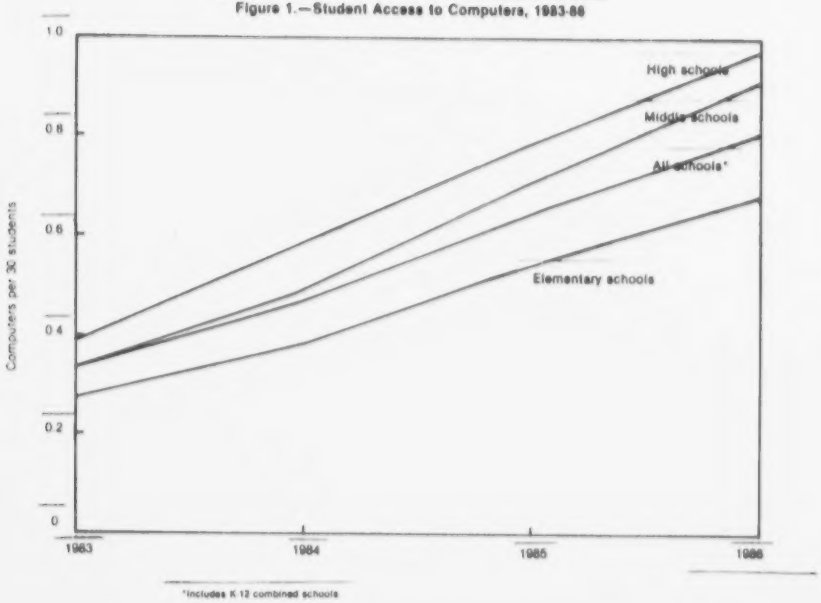
A Necessary Infrastructure

Because of this rapid diffusion and incomplete understanding about effective uses of computers for instruction, schools face many barriers in implementing the technology so as to improve the educational process. OTA found that now that most schools have "introduced" the computer, the harder task is yet ahead — integrating the technology into the curriculum. Making effective use of the technology involves a number of essential ingredients: adequate hardware, appropriate software, and training and support for teachers. Planning at all levels plays a critical role in bringing a useful program together. But many questions remain. For example, what kind of training and support is needed both now and in the future as technology advances and as we gain better understanding of how to use it in the classroom? What kind of software do learners need for traditional subjects and for new learning processes not yet being taught? How will advances in technology and in our understanding of the learning process influence future development and potential of technology for education? These are questions that speak to the transition underway. It is these areas that OTA is currently examining to provide direction for public policy. We look forward to sharing our findings with the Committee next Spring.

This first wave of computer-based technologies in education is characteristic of the way that many new technologies proliferate — in a decentralized, piecemeal fashion.

However, we are continuing to learn about the conditions under which computers are successfully integrated into the traditional curriculum and are successfully applied to new frontiers of learning.

Figure 1.—Student Access to Computers, 1983-86

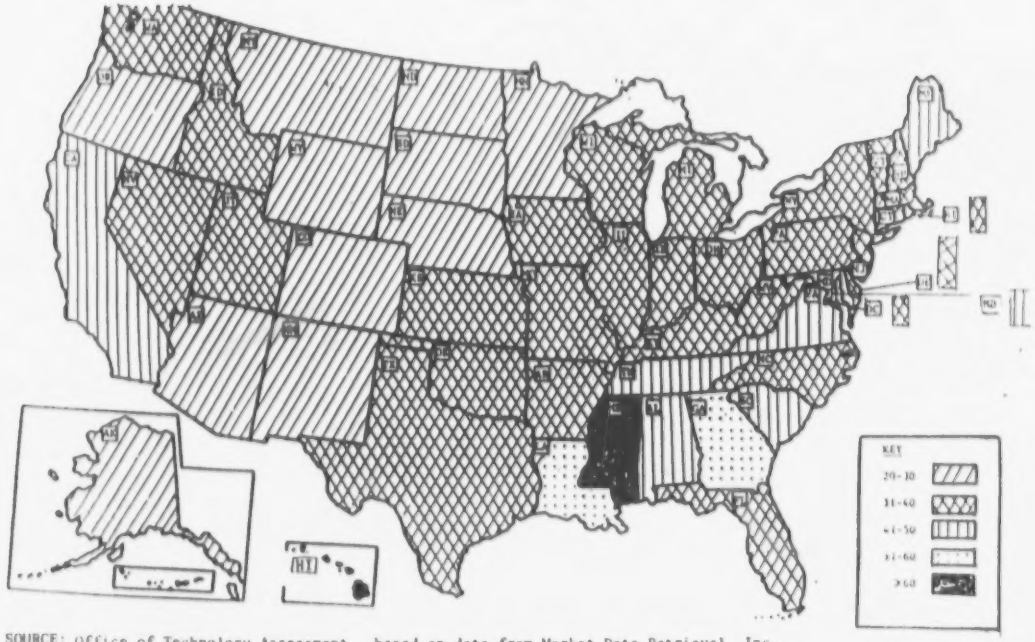


*Includes K-12 combined schools

SOURCE: Office of Technology Assessment, based on data from Market Data Retrieval, Inc., Westport Connecticut, 1986.

FIGURE 2

CROSS-STATE DIFFERENCES IN AVERAGE NUMBER
OF STUDENTS PER COMPUTER, 1986



SOURCE: Office of Technology Assessment, based on data from Market Data Retrieval, Inc. Westport, CT, 1986.

Senator LAUTENBERG. We would ask Marc Tucker to be next.

Mr. TUCKER. Thank you very much for the opportunity to testify at this hearing today. I am Marc Tucker. I am Executive Director of the Carnegie Forum on Education and the Economy.

We issued a report last year, "A Nation Prepared: Teachers for the Twenty-First Century", that started out with a simple premise, namely that this country, if it decides to compete, economically, on the basis of low-skilled labor, is going to lose because we charge about ten times as much for our low-skilled labor as the rest of the world does.

We said, as a consequence, what we have to is to totally redesign our education system—not change it a little, not change it incrementally, but change it so that we can offer to almost everybody in this country a kind and quality of education that up until now we have reserved for a small elite. We need to become, the report said, "A nation that thinks for a living."

The core of our report related to teachers. We said that it would take a highly educated, highly paid teaching force to produce a nation of workers that can, in fact, think for a living.

But to get such workers, without breaking the bank, we are going to have to make sure that we don't use professional teachers where somebody less trained is going to do the job.

We're going to have to analyze schools to restructure jobs. We're going to have to assign only real teaching duties to teachers and hire less-well-paid people to watch the traffic, keep the records, do the copying, and countless other chores. We're going to have to make sure that we make the most efficient use of teachers by giving them all the help technology can provide for the simple tasks, copying documents, keeping track of student progress, and so on.

All this is neither more nor less than business does for professionals in every other field, but it is not what we do for teachers. Business does not provide clerical help, copying facilities and computer-based equipment to professionals to be kind to them; it does it to get the most out of their investment in expensive personnel.

It is even perfectly reasonable to think that computer-based systems can help us to make the most efficient use of first-rate teachers by taking over one of the tasks that many people now think of as central to teaching: providing information.

Much has changed since the simpler days when teachers were first saddled with the responsibility to stand before the class to serve as a transmitter of information to students. Few teachers can now, or should try, to compete with modern electronic systems in their capacity to provide students with access to lectures, tutorials, documents—and not least, data.

Now, freeing teachers from this ancient task will enable us to redesign schools so that every student can get the individual attention of the professional teacher that has long been our aim. But in my opinion, the most important use of advanced technology in our schools will not be to support the work of teachers; it will be to support the work of students.

Students with easy access to fully equipped word processors find that writing is easy, editing does not require laboriously rewriting whole pages, just hitting a few keys. Dictionaries highlight spelling

problems; electronic thesauruses help build vocabulary quickly. Grammars point out grammar errors. Neatly printed copies of what the students write can be produced at the touch of a button. Those they share it with can comment on it, edit it or extend it, all without destroying the original.

As we heard this morning, these young writers have very active audiences, and that is clearly the best motivation for anybody to write anything. I don't doubt but what the widespread use of such machines will produce a dramatic increase in the ability of our students to read well and to write well.

But it is important to note, this is not computer-assisted instruction. The machine doesn't teach a thing. It doesn't deliver instruction. The software required is not instructional software; it's tool software, a tool not for the teacher, but for the student.

These tools exist right now in a simple form for young students, in more sophisticated versions for older students. Parallel expressive software tools exist in the realm of art and music. Simulations and models exist, and many more should be developed that create environments in which students can explore and come to intuitively understand the properties of a great range of dynamic systems, from the workings of our economy to the infinitely complex organism that is the human body.

Other tools, designed for the manipulation of data, tools like spread sheets and data base management systems, as you heard this morning, provide a means for students to assemble data, to ask questions of it, to see what patterns emerge. Using such tools, they can begin to develop a deep understanding of the way factors combine to determine the course of human history, and so on.

Now, there are two things that are essential: first rate teachers and widely available computers. Computers are the most universal tools we have ever invented. Imagine that we took a much less powerful tool—the pencil—and said to students that we'd give out one pencil for every 40 students. That's where we are right now in the United States of America.

If this is the tool I think it is, we need to have one computer to every two, every three, or every four students.

Senator LAUTENBERG. It's a very good example that you ended with there, about whether we would sit still if we had only a limited number of pencils to hand out. That's quite a comprehensive statement you made on the whole education system. We appreciate it. If you would, again, the testimony will be fully included.

[The prepared statement of Mr. Tucker follows:]

Prepared Statement by

Marc S. Tucker
Executive Director
Carnegie Forum on Education and the Economy
Washington, DC

to the

Subcommittee on Education, Arts and Humanities
Committee on Labor and Human Resources
United States Senate
4 August 1987

Thank you, Mr. Chairman, for the opportunity to testify today.

In 1981, I had the good fortune to receive a grant from Carnegie Corporation of New York to do some research on the use of computer and communications technology in our schools, with a focus on state and federal policy issues, the topic of today's hearing. For reasons that I hope will be apparent in a few minutes, I concluded that one of the shrewdest investments this country could make would be a significant federal commitment to advance the use of computers in the schools.

Four years later, in 1985, I became the Executive Director of the Carnegie Forum on Education and the Economy. Last year the Forum issued a report, A Nation Prepared: Teachers for the 21st Century, which received a great deal of attention. Its central points were very simple. First, we are competing with nations whose production line workers are both better educated than ours, and prepared to work for a tenth of the wages our workers are paid. Second, because we cannot compete on wages, our standard

of living will steadily fall unless we choose to compete on skills, that is, unless our workers reach the ranks of the best educated in the world. Third, it is simply impossible to produce a very highly educated workforce unless we have first-rate teachers in our schools, teachers who can prepare our children to think for a living. Much of the report is devoted to a discussion of what it will take to make sure that a reasonable share of the best and brightest college graduates in the country choose to make a career of teaching.

I want this morning to join these two themes, to show how first-rate teachers and computer-based technology can together provide the kind of workforce this country needs.

First, some comments about the education challenge. Other countries, both advanced and less developed, are doing a better job of providing the basic skills to their workers than we are. Among those countries, the ones that pay low wages are ideally positioned to produce internationally traded goods and services that require only modest skills in their workers. That means that the United States, if it is to remain a high wage country, must leave the routine work of the world to others and concentrate on work that requires a much higher skill level of the average worker. Even if we were to get much better at providing the basic skills, then, the best we could hope for in the long term is matching the wage levels of our low-wage

competitors. We must shoot for a much higher target.

What we have are schools designed to produce workers with routine skills for routine jobs. Most courses, for most students, consist of teachers presenting a set of facts, a set of procedures and a vocabulary to students for them to master more or less by rote. What we need is schools that provide much higher skill levels. We need students who have a good intuitive grasp of the ways in which all kinds of physical and social systems work, a feeling for what data is and how to use it, a cultured creativity that leads them to new problems and new solutions, and an ability to communicate effectively with others. These students, in short, will need to have a deep understanding of the tough subjects in the curriculum and the ability to apply what they know creatively to an endless succession of novel, non-routine problems. That is what employers mean when they say they need employees who can think.

The United States has for a long time produced an elite with these skills. The challenge now is to design a mass education system that will turn out millions of students every year who have those skills.

It will take highly educated, highly paid teachers to produce a nation of workers that can think for a living. To get such teachers without breaking the bank, we will have to make sure

that we don't use professional teachers where someone less well trained will do, so we will have to analyze schools to restructure jobs assigning only real teaching duties to teachers and hiring less well paid people to watch the traffic, keep the records, do the copying, and countless other chores we now assign to teachers. And we will have to make sure that we make the most efficient use of teachers by giving them all the help technology can provide -- for copying documents, keeping track of student progress, analyzing student problems and countless other tasks. All this is neither more nor less than business does for professionals in every other field, but not what we do for teachers. Business does not provide clerical help, copying facilities and computer-based equipment to professionals to be kind, by the way, but simply to get the most out their investment in expensive personnel.

It is even perfectly reasonable to think that computer-based systems can help us to make the most efficient use of first-rate teachers by taking over one of the tasks that many people now think of as central to teaching -- providing information. Much has changed since the simpler days when teachers were first saddled with the responsibility of standing before the class to serve as a transmitter of information to students. Few teachers can now -- or should try -- to compete with modern electronic communication systems in their capacity to provide students with access to a wealth of lectures, tutorials, documents, and data.

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Freeing teachers from this ancient task will enable us to redesign schools so that every student can get the individual attention of the professional teacher that has long been our aim.

However, the most important use of advanced technology in our schools will not be to support the work of teachers, but rather to support the work of students.

Students are the most important workers in our schools. They work with information. If we want to improve the quality of their work, if we want to make them more productive, then we have to do for them what we have to do for every other information worker in our society: we have to provide them with access to the extraordinarily powerful tools of modern information technology to get their work done.

Students with easy access to fully equipped word processors are finding that writing is wonderfully easy, and editing does not require laboriously rewriting the whole page, but just hitting a few keys. Electronic dictionaries highlight spelling problems. Electronic thesauruses help build vocabulary fast. Computer-based grammars point out grammar errors. Neatly printed copies of what students write can be produced at the touch of a button. Those they share it with can comment on it, edit it, or extend it, all without destroying the original. These young writers have very active audiences, the best

motivation for writing.

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Parallel expressive software tools exist in the realm of art and music. Simulations and models exist and many more should be developed that create 'environments' in which students can explore and come to intuitively understand the properties of a great range of dynamic systems, from the workings of our economy to the infinitely complex organism that is the human body.

Other tools designed for the manipulation of data -- tools like spreadsheets and data base management systems -- provide a means for students to assemble data and ask questions of it, to see what patterns emerge. Using such tools, they can begin to develop a deep understanding of the way factors combine to determine the course of human history, to cause or abate

pollution in industrial systems, to account for population growth and control, to cause a financial panic or break a budget.

In time, students who routinely use computer and communications systems in the way I have described would become a nation of workers who could add far more value to the work they did than our current workers can. Not only would the use of information technology be second nature to them in every task they approached, but they would be systems thinkers, problem solvers, creative people, and, perhaps most important, they would have learned how to learn, would know how to sort fact from fiction, how to decide whether a given fact is relevant, why one procedure works and another does not. They will be the most productive workers in the world.

Two things are required to get there: first rate teachers and widely available computers. Computers will provide the means to write and edit easily and quickly, but only highly skilled teachers can help students to write well. Computers are wizards at handling and displaying data, but only teachers can help students to derive meaning from that data.

Computers are the most powerful universal tools ever invented. Imagine now that we took a much less powerful tool -- the pencil -- and said to students that we would give out one pencil for every forty students (the current ratio of computers to

students). And then we said that what we were going to do with pencils was give courses in pencil literacy -- the history, structure and social consequences of the pencil. You would be outraged. For heaven sakes, you would say, just give the students pencils, and let them use those pencils in every course in the curriculum.

The legislative proposal before you springs from this view of the potential of the computer, a view I obviously share. While I believe that a massive program to provide one computer for every two to four students would be wholely justified by the likely return on that investment, the current condition of the government's checkbook -- much like my own -- makes that very unlikely, at least for the present. The proposal before you is much more prudent. Without breaking the bank, it will help the schools make these powerful tools available to students, will address the very important problem of inequitable access to computing for disadvantaged students, will help to prepare teachers to make appropriate use of these machines in the classroom, will provide incentives to school districts to plan carefully for the use of these resources across the whole school curriculum, and, not least important, will enable the Department of Education and the National Science Foundation to conduct and disseminate the results of research on effective uses of computers and sound approaches to teacher training. It is a sound approach.

Senator LAUTENBERG. We now ask Dr. Becker to testify—under the same constraints, unfortunately. I know how hard everybody has worked and how much information you have acquired, and it would enrich our lives here substantially, including the legislation, if we had more time, but we don't.

Dr. BECKER. Senator Lautenberg, I am Hank Becker. I am a research scientist at Johns Hopkins University.

During the past 5 years, I've conducted two national surveys that describe how schools use computers. I think some of the chart data may have come from some of the work that I had done. This fall, I am beginning a series of controlled experiments where I hope to measure the comparative effects of using computer-based instruction and traditional instruction in typical classrooms.

I'm a computer enthusiast, and I do believe that, over time, it's inevitable that we will see computers, video and the software that run them, become a tremendous presence in American schools, even if they remain more costly than other methods. But right now, the bill speaks to the current situation, and that's what I would like to address here.

There is no doubt that schools need help in knowing what to do about computers and how to do it. In many places, although not perhaps in Hartford and in Newark, as we've seen today, schools haven't adequately thought through decisions for acquiring and using computers.

Some schools have made essentially defensive responses to vague pressures from parents that their kids should become familiar with computers.

Schools have generally acquired computers on a piecemeal basis.

Teachers have been given insufficient opportunities to learn how to integrate the computer activities with the rest of the curriculum.

Many schools have poorly sequenced activities, for example, avoiding or denying the fact that typing skills are valuable to use computers as writing instruments.

Others have spread a few computers among many classrooms, preventing any single teacher from having enough computers to use with their students.

By choosing to invest in microcomputers and computer software in, really, its very first generation, schools, in some respects, have saddled themselves with computers of limited capacity and programs which, although valiant in ambition, may or may not make a measurable difference in what students learn.

The survey picture was certainly not bleak. The survey that I conducted found that teachers were very optimistic in certain respects. They believed that the computers made school life much more enjoyable—improving the enthusiasm of the students, motivating them to work harder. They believed, that the drill and practice programs they were using with low achieving students were motivating them to make a greater effort to learn basic skills.

They saw computers as particularly valuable for the gifted, bright and more mature students, enabling them to learn independently of adults and to give them skills that they would be able to use later in their work and college life.

But, on the whole, teachers did not believe that computers had yet been able to make a difference for average students and for most students' learning of traditional subjects, or to improve their performance on problem-solving, thinking, or writing tasks.

I think it's clear that teachers' accomplishments have been limited because they've had too few computers and too few copies of programs to manage instruction for classes of students at one time. For example, in 1985, only 10 percent of the elementary school classrooms that had computers had more than three of them.

But accomplishments may have been limited for other reasons: because the computers may have been too limited to run software of sufficient complexity; because teachers hadn't been given an opportunity to integrate the computer activities with the rest—and they strongly felt that was the case—and because schools have historically, been better at providing factual knowledge than empowering students with greater intellectual capacity.

So merely providing hardware and software that could theoretically help students write and think more clearly will not necessarily change the habits and practices of schools. It's important that we consider alternative ways of helping schools in addition to giving them the opportunity to buy existing hardware and software.

We should support schools' efforts to acquire more computers and software if we have evidence that such purchases will enable students to learn more or better. But to the extent that we don't have satisfactory evidence, we should, instead or at least in addition, support efforts to collect information about the effectiveness of current practices, and we should support curriculum projects that enable teachers to use existing software more successfully.

Moreover, to the extent that the educational goals that we see for computers require more sophisticated hardware and software, efforts ought to be directed toward longer-term investments in curriculum and software development.

In considering funds for computer education, this bill is actually addressing three quite different educational goals for which the same technology happens to be relevant: basic skills, higher order thinking, and the use of computers to teach about computers.

It's clear that the decisions that are made to fund particular projects have to pay attention to what we know that computers—current computers—can do in each of those areas and must consider the alternatives—funding development projects and evaluations that would extend the value of computers in the future.

Senator LAUTENBERG. Thank you very much, Dr. Becker.

[The prepared statement of Dr. Becker follows:]

STATEMENT ON
SENATE BILL S. 838
THE COMPUTER EDUCATION ASSISTANCE ACT

by

Henry Jay Becker, Ph.D.
Research Scientist

The Johns Hopkins University
Center for Social Organization of Schools
and
Center for Research on Elementary and Middle Schools

August 4, 1987

I am pleased to be able to provide some information and commentary relevant to your subcommittee's consideration of Senate Bill S-838, to provide financial assistance to the states for computer education programs.

My name is Henry Jay Becker. I am a research scientist at the Johns Hopkins University Center for Social Organization of Schools and the Center for Research on Elementary and Middle Schools. During the past five years, I have conducted two national surveys that describe how American schools are using computers in their instructional programs. I am now beginning a series of field studies, using controlled experimental designs, that will compare the effects of computer-based and traditional approaches to instruction on student achievement in typical school settings.

I am among those people whose lives have been irrevocably transformed by computers -- for whom computers are a constant part of life in both work and play. But, as a sociologist, I try to maintain some detachment in appraising the value of computers for other people in other circumstances with other needs and interests. Businesses buy personal computers and computer programs in great numbers with scarcely a thought. But many schools hardly have the funds to keep class sizes to adequate levels or to obtain books and other essential resources for instructing students. So, acquiring substantial numbers of computers and disks containing software becomes a momentous decision. Thus, it is critical for schools to make appropriate assessments about the appropriate times and the appropriate functions for which to invest in computer-related resources.

There is no doubt that schools need help in knowing what to do about computers and knowing how to do it. In many places, schools have inadequately thought through decisions for acquiring and using computers. Schools' decisions have often been characterized by defensive responses to vague pressures from parents to provide some opportunities -- of almost any kind -- for their children to become familiar with

computers. Some have used the ownership of expensive computers as a symbol of school pride and fashionableness. Many schools have acquired computers in a piecemeal way, and sometimes an incompatibility among machines in the same classroom has resulted. There has been inadequate budgeting for software to use with hardware already acquired and meager opportunities for teachers to learn how to blend computer and non-computer activities into an appropriate mix to achieve a specific curricular goal. Many schools have inadequately sequenced activities -- for example, ignoring pre-requisite keyboard skills required for effective use of computers as writing tools. Others have overly decentralized available equipment among classrooms, preventing teachers from using computer activities with large fractions of a single classroom at one time. And, all of these schools, by their choice to invest in microcomputers and microcomputer software in its very first "generation" of existence, have in some ways saddled themselves with computers of limited capacity and programs which, though valiant in ambition, may or may not be quite up to the task of helping teachers and schools make a measurable difference in what students learn.

And yet in spite of these problems, it is almost inevitable that, over time, computers, video and information technology, and the software that gives them value will become important elements in school instructional programs, even if they remain more costly than alternative media for providing instruction. It is technically within our means to develop truly sophisticated programs that make computers into highly responsive, interactive tutors and tools that stimulate children's thinking, that diagnose and correct misunderstanding, that provide editorial assistance, and that open students to new experiences and intellectual challenges in ways clearly superior to any alternative. And even with somewhat more limited computers accessible to schools today, teachers can produce or be provided with instructional models for using existing computer software as part of a well thought-out program for helping students to think, write, and approach intellectual and social problems with greater sophistication.

But, it is hard to reconcile these images with data that describes school computer use in the past few years -- the first years after microprocessor technology has allowed computers to be within the financial reach of schools.

A Portrait of School Computers and their Instructional Uses

In the past five years, computers have become a presence in nearly every U. S. elementary and secondary school. In 1982, only one in five elementary schools had any computers at all used for instruction and, although a bare majority of secondary schools had computers, only 20% had as many as five computers in their building. By the Spring of 1985, five out of six elementary schools had computers used for instruction and a majority of high schools had 15 or more computers -- enough to accommodate a full classroom at one time, with some sharing of keyboards. Today, with schools continuing to purchase equipment, a comparable survey would be likely to show that the computer-to-student ratio in elementary schools is roughly what it was in secondary schools just two years ago and that the number of computers in a typical high school is approaching 40.

From another perspective, though, this growth is more akin to growth in utero -- large gains proportionally, but small in relation to its potential. Even today, schools have computers enough to serve each of their students for only an hour or two each week. Yet the promise of computers -- for assisting in basic skills mastery, in written composition, in higher math and science learning, in foreign languages, social studies, art, and music, for vocational preparation, for learning computer-specific skills like programming, and for general intellectual development -- would many times over exceed schools' current limited supply of equipment, if all these possibilities indeed brought their promised advantages.

Given a limited resource like computers, schools can either limit the number of children who use them, giving each user a substantial experience, or they can limit the

time alloted to each user, spreading computer access to as many students as possible. The choice that a school makes reflects its basic orientation towards computers. Either a computer is a cultural artifact with which all members of the culture should have some modest familiarity, or it is a tool to be used to provide a significant learning experience not otherwise available, offered to a necessarily limited number of students.

Overall, elementary schools have tended to follow the first model, spreading access to more students, each of whom get only limited exposure, and secondary schools have tended to provide access to a smaller proportion of their students but to give those users more computer time.

As a result, the number of students who use school computers is at its maximum at grade 5 and tails off at higher grade levels. Eleven percent of all computer-using students in 1985 were 5th graders, but only 4% were ninth graders. (See Figure 1 on the next page.) However, the typical computer-using **high school** student in 1985 had nearly **four times** the amount of computer time during any one week than did an elementary school student using computers during the same week (2 hours vs. 30 minutes per week). Nearly one-quarter of computer-using high school students used computers for 4 or more hours per week. In contrast, fewer than 10% of the elementary school computer-users got as much as two hours during the week to use computers.

Computer Time Allocations Within Schools

Within a school, older students tend to get a disproportionate amount of computer time. Thus, in 1985, total computer time among elementary school students peaked at grades 5 and 6. Among middle school students, the peak was at grade 8. And nearly two-thirds of the computer time among high school students was spent by 11th and 12th graders. These differences may be because older students have greater prestige in a school and are rewarded by having access to widely valued resources like computers. Or the older students' schedules may be more flexible leading to more time for "enrichment" activities such as using computers. A third possibility is that computers may in fact be

Figure 1: Percent of All Computer–Using Students who are in Each Grade, Spring, 1985

more functional for older students who are less likely to need close supervision and more able to work themselves out of difficulties encountered in using computer programs without adult assistance.

Boys and higher-ability students also use school computers disproportionately, although not in all respects. The sex discrepancy is greatest where computer activities are least connected to school curricula -- in before- and after-school activities, in game playing in secondary schools, and in elective programming activities in elementary school. (See Table 1.) Parity between boys and girls is most often found in computer-assisted-instruction activities, in writing and word processing, in elementary-level learning games, and in programming activities in secondary school. Although people usually perceive girls as being underrepresented in programming activities, on a national basis the differences in high schools are small, especially where curricular requirements exist for entry into programming classes. On the other hand, the students who are most noticeably involved with computers are disproportionately boys. In the 1985 survey, computer-using teachers were twice as likely to name a boy as the student who had been the most affected by their experience with computers in school.

Academic achievement differences are at least as significant as sex differences in affecting the allocation of available school computer time among students and in the ways that students use computers. For example, students in the top third of their class standings were more often disproportionately included among the dozen or so most active computer-users than boys were. And in most schools, "top-third" students used school computers more than students in the "middle third," for all aspects of computer use except game playing. Higher-ability students were particularly dominant in programming activities, but even in such areas as word-processing and overall computer use, the higher-achieving students used computers more than average students did in about one-half of the schools. (See Figure 2.)

Table 1: Percent of Computer-Using Students Who Are Female, by School Level and Type of Use, Spring, 1985

(Median Percent Female Among Schools Using Computers in that Way)

Type of Use	Elem. (K-6)	Middle School	High School
Overall Computer Use	50%	50%	50%
Before & After School	30%	15%	20%
Word Processing	50%	50%	60%
Programming	9%	45%	44%
Game Playing	50%	30%	10%

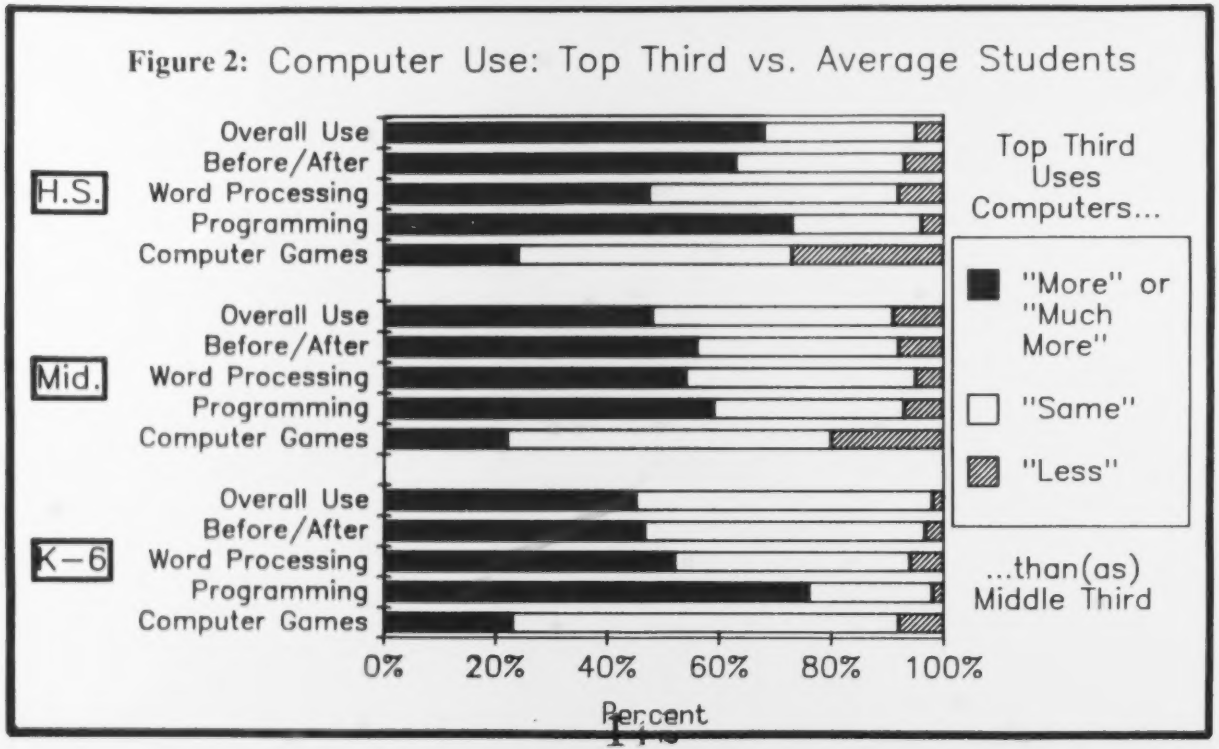


Figure 2: Computer Use: Top Third vs. Average Students
H.S.
Mid.
K–6
Overall Use
Before/After
Word Processing
Programming
Computer Games
Overall Use
Before/After
Word Processing
Programming
Computer Games
Overall Use
Before/After
Word Processing
Programming
Computer Games
0%
20%
40%
60%
80%
100%
Percent
Top Third Uses Computers...
"More" or "Much More"
"Same"
"Less"
...than(as) Middle Third

What is Taught Using School Computers

The subjects that students studied with computers differed substantially between elementary and secondary schools. More than three-quarters of the computer time spent by kindergarten through third-graders was spent on mathematics, reading, and language arts (primarily drills and games). Only 13% of high-schoolers' computer time went for those subjects. (See Table 2.) The major activity among high school computer-users was computer programming -- 42% of their computer time. The second-most common use of computers by high school students was in business education classes (18%), primarily for word-processing. Most high schoolers' word-processing occurred in those courses rather than as part of an English class. A very small proportion of students' computer time was spent on science subject-matter and on high school level mathematics.

For the most part, computer-using teachers saw the value of computers primarily as providing motivation for students. Except at the highest grade levels, the most common function of computers for computer-using teachers was as an enrichment activity to help make the school day more enjoyable. Fewer than 25% of teachers at the elementary grades saw computers as a basic part of the regular instruction in a subject-matter. (See Figure 3.)

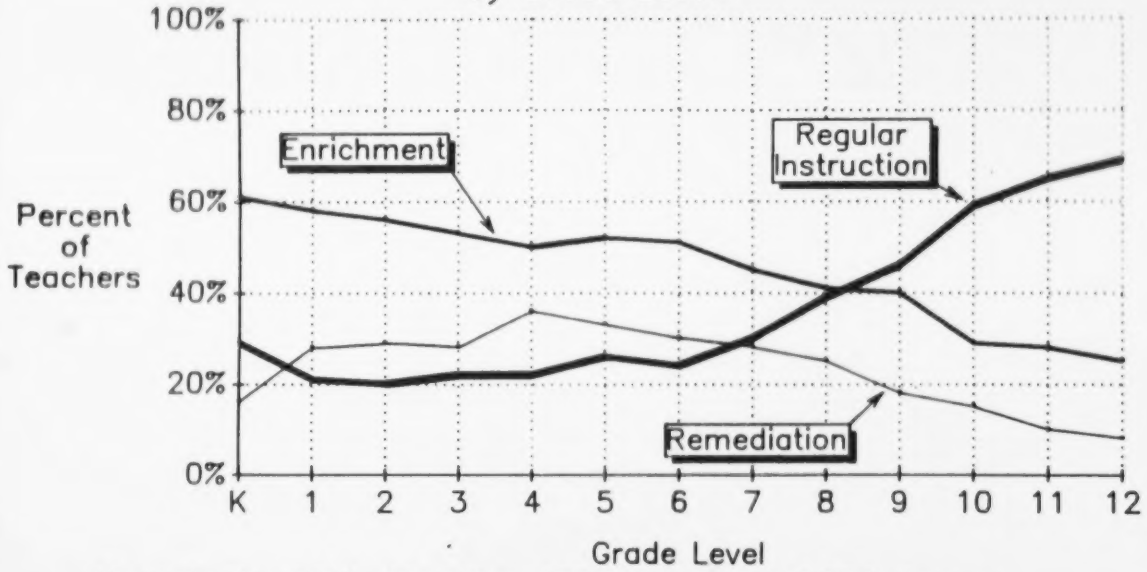
Among classes at the same grade level, school computer activities differ substantially between classes of high-achieving, average-achieving, and low-achieving students, particularly in the middle grades. The pattern of computer use in fourth- through eighth-grade classes of low-achieving students resembles the overall pattern for all classes in grade two -- a strong concentration on drill and game programs emphasizing basic math and language arts mechanics. In contrast, the pattern for classes of high-achieving middle grade students resembles the overall pattern in grade 11, with an emphasis on programming activities, problem-solving exercises, and word processing. In the 1985 survey, problem-solving, programming, and computer literacy constituted only 13% of the computer activity of low-ability classes, 38% of the time of mixed-ability classes, and 61% of the time in high-ability classes in grades 4-8. (See Table 3.)

Table 2: Distribution of Computer Use, by Subject and Grade Level, Spring, 1985.*

SUBJECT (from course title, activity, and software in use)	GRADE LEVELS OF STUDENTS IN CLASS K-3	4-8	9-12
Mathematics**			
Topics below algebra or unspecified math	42%	27%	5%
Algebra, geometry	0%	1%	1%
Trig,. advanced math	0%	0%	1%
Subtotal: traditional math subjects	42%	28%	7%
English			
Language arts and spelling	18%	12%	4%
Reading	17%	8%	2%
Subtotal: language arts	35%	20%	6%
Writing	2%	2%	3%
Word processing in English class	3%	3%	2%
Subtotal: writing	5%	5%	5%
Computers and Problem-Solving			
Math topics: problem-solving, logo, programming activities	3%	6%	2%
Programming*** as specific topic or course	2%	13%	42%
Logo as specific topic****	4%	5%	1%
Computer literacy as specific topic or course	6%	10%	5%
Subtotal: computers & problem-solving	14%	34%	50%
Business and Word Processing			
Business, accounting, secretarial, other than word processing	0%	0%	6%
Word processing, other than in English	1%	2%	12%
Subtotal: business	1%	2%	18%
Other Subjects			
Science and nutrition	1%	3%	7%
Social studies	1%	4%	1%
Industrial arts and agriculture	0%	1%	5%
Others	2%	2%	2%
Subtotal: other subjects	4%	11%	15%
Total for All Subjects	100%	100%	100%

*Sum of individual entries may not equal subtotal entry because of rounding. Similarly, subtotals may not sum to grand total.
**See also first entry under 'Computers.'
***Excludes specific mentions of Logo.
****Includes some general problem-solving not classified elsewhere.

Figure 3: Function of Computer Activity for Teachers--Enrichment, Remediation, or Regular Instruction--by Grade Level*



*Percents May Add to More than 100% Because of Multiple Answers.

Table 3: Distribution of Computer Use, by Subject and Ability Level, Upper-Elementary through High School, Spring, 1985.*

SUBJECT (from course title, activity, and software in use)	GRADE AND ABILITY LEVELS OF STUDENTS IN CLASS: Grades 4-8 Low(29%)	Grades 4-8 Mixed(59%)	Grades 4-8 High(12%)	Grades 9-12 Low(13%)	Grades 9-12 Mixed(78%)	Grades 9-12 High(9%)
Mathematics**						
Topics below algebra or unspecified math	36%	27%	9%	32%	1%	0%
Algebra, geometry	2%	1%	3%	1%	1%	2%
Trig,. advanced math	0%	0%	0%	0%	1%	3%
Subtotal: traditional math subjects	38%	28%	12%	32%	3%	5%
English						
Language arts and spelling	20%	10%	4%	16%	2%	1%
Reading	19%	5%	2%	13%	0%	2%
Subtotal: language arts	39%	15%	6%	29%	2%	3%
Writing	5%	1%	6%	4%	2%	9%
Word processing in English class	1%	3%	4%	5%	1%	5%
Subtotal: writing	6%	4%	10%	9%	3%	14%
Computers and Problem-Solving						
Math topics: problem-solving, logo, programming activities	4%	6%	10%	3%	1%	2%
Programming*** as specific topic or course	2%	14%	25%	4%	50%	32%
Logo as specific topic****	3%	6%	8%	2%	1%	1%
Computer literacy as specific topic or course	4%	12%	18%	6%	5%	4%
Subtotal: computers & problem-solving	13%	38%	61%	15%	57%	40%
Business and Word Processing						
Business, accounting, secretarial, other than word processing	0%	1%	0%	0%	7%	2%
Word processing, other than in English	2%	1%	2%	6%	13%	11%
Subtotal: business	2%	2%	2%	6%	20%	13%
Other Subjects						
Science and nutrition	1%	5%	2%	2%	6%	10%
Social studies	0%	6%	6%	3%	1%	3%
Industrial arts and agriculture	0%	1%	0%	2%	7%	0%
Others	2%	3%	3%	3%	2%	3%
Subtotal: other subjects	3%	14%	10%	9%	15%	24%
Total for All Subjects	100%	100%	100%	100%	100%	100%

*Sum of individual entries may not equal subtotal entry because of rounding. Similarly, subtotals may not sum to grand total.
**See also first entry under 'Computers.'
***Includes specific mentions of Logo.
****Includes some general problem-solving not classified elsewhere.

The fact that students in different academic ability-groups use computers so differently should not be surprising. Nor is it necessarily inequitable. It is merely indicative of the great variety of instructional functions to which computers can be put and the fact that different students require different emphases in their curriculum. But it also may arise because certain uses of computers require teachers to rely on students to solve operational problems and make decisions without close adult supervision. The less sophisticated the instructional software (and the hardware within whose constraints the software works), the more difficult it is for students to work without assistance. To extend computer opportunities that emphasize higher-order thinking and problem-solving to less advanced students requires sophisticated software that enables itself to be easily used and that provides more explicit connections between examples and principles.

There is evidence that schools have used computers more successfully with special populations (the gifted and the slowest learners) than it has with the larger group of students in the middle achievement ranges. When we asked computer-using teachers to report the most important way that computers helped their students to "learn more, learn better, or learn faster," one-third of teachers of mixed-ability classes said that computers hadn't helped at all -- roughly twice the proportion of teachers giving this response for high- or low-achieving classes. One reason may simply be that mixed-ability computer-using classes suffer from a poorer ratio of students to computers than do either low-or high-ability classes. The mixed-ability classes tend to be somewhat larger than the gifted classes (and much larger than the special education classes). And they have fewer computers available to them. In 1985, mixed-ability classrooms in the middle grades that used computers in their own classroom typically had only one or two computers -- and twice as many students per computer (20-1) as high-ability classes (10-1) and four times as many students per computer as low-ability classes using computers (5-1). Twenty students and one computer! What accomplishments could reasonably be expected!

In 1985, the range of software and the number of instructional computer programs for certain subjects like science and social studies was still quite limited. At the time,

most experts in educational computing were downplaying computer programming and simple math and English drill-and-practice as preferred activities and were encouraging such uses as word processing and other computing "tools." Yet the 1985 survey found that the dominant computer activity at the high school level was computer programming and the dominant activity in the elementary grades was drill-and-practice in arithmetic and in the mechanics of language arts and reading. It is important to note that of all instructional uses of computers, computer programming makes the fewest demands on the software budget (because typically the only item of software required -- the programming language -- comes with the machine), and basic skills drill-and-practice makes the fewest demands on the teacher's computer expertise (in terms of the minimum level required to use the programs).

Accomplishments to Date -- and Their Limits

The 1985 survey essentially found that teachers using computers were accomplishing what their circumstances allowed them to. In spite of having a small number of computers and relatively unsophisticated instructional software, they were making school life more enjoyable -- improving the enthusiasm of students and presumably motivating them to work harder at their other tasks as well. With simple drill-and-practice software that could occupy the attention of often bored and sometimes disruptive low-achieving students, and they could motivate these students to give more effort to learning basic skills. Many believed they were making some actual difference in achievement with this harder-to-teach population. And teachers saw computers as particularly valuable for providing special opportunities to bright and more mature students, from enabling them to learn independently of adults to giving them computer-related skills like introductory programming that could help them in college and work life. But, on the whole, teachers believed that computers had not yet functioned to improve the school experience for average students, nor had it made a major difference in student learning of traditional subjects for most students nor significantly improved

most students' understanding of complex ideas or their performance of complex problem-solving, thinking, or writing tasks.

The teachers' accomplishments may have been limited because they were operating with far fewer computers and copies of software programs than they needed to effectively manage instruction for a class of students at one time. In 1985, only 10% of the elementary school classrooms that had computers had more than 3 computers present.

Having only a few computers available in a classroom limits the amount of experience that any one student has with computers and the likelihood that the student could make substantial gains in achievement even if the software is extremely well-designed to promote that achievement. In addition, having a limited number of computers requires teachers to attend more closely to problems of classroom organization -- how to circulate students among different activities because the whole class cannot be accommodated at one time on the same task.

But accomplishments may have been limited for other reasons: because the computers acquired by schools severely limited the sophistication of the instructional and productivity software that could be written (and sold); because teachers had not been given an opportunity to plan how to integrate computer software with other instructional activities in a coherent curriculum; and because school instruction has historically been oriented to providing factual knowledge rather than empowering students with greater intellectual capacity. Merely providing hardware and software that might help students write and think more clearly will not change the habits or practices of schools and teachers.

Funding Computer Education Expenditures and Research and Development

Given the arguably inadequate results of schools' efforts over the past five years to cope with the emerging microcomputer technology and given the educational potential that structured, interactive communication through this medium has, large-scale Federal

investment in developing the potential for computers to improve public and private education seems very reasonable.

Five types of contributions ought to be considered: contributions towards the purchase of existing computer hardware and software; contributions in the form of training, advice, and technical support for making decisions about acquiring and using existing materials; investment to improve how teachers can use existing hardware and software to support their pre-existing instructional goals; investment to develop more sophisticated instructional materials that make use of computer technology that is not yet available to schools; and investment in research to evaluate the worth of both existing and new approaches that use computers.

The relative emphasis on each of these efforts ought to depend on (a) how knowledgeable we are about the value of currently marketed equipment and programs for accomplishing particular educational goals and (b) how much potential that future hardware and software development will have for improving the value of computer-based approaches towards those goals. To the extent that evidence exists indicating that current materials are effective, we should support further acquisition; to the extent that no satisfactory evidence exists, we should support evaluations that provide this information and development activities that improve the value of existing software by enabling teachers to use it more successfully. To the extent that the educational goals require more sophisticated computer-based approaches than schools have accessible right now, efforts ought to be directed towards longer-term investments in curriculum and software development that will enable future computer-related hardware to be immediately applicable to schools as soon as it becomes affordable.

In considering funds for "computer education," this bill is actually addressing several quite different educational goals for which the same technology happens to be relevant: improving basic arithmetic, reading, and language arts skills of students, particularly students who are now failing to master such skills; improving the thinking, reasoning, problem-solving, and written expression skills of students at all school levels; and

providing computer-specific competencies relevant to future adult occupational roles. Which contributions and investments are most appropriate to each of these educational goals will depend on how well current computer-related products serve that particular goal and on how likely that more sophisticated approaches not represented in today's marketplace would better serve that goal.

Each function that computers might serve in education needs to be evaluated in terms of its value for advancing student skills, knowledge, and capacities. The value of using computers for basic skills learning needs to be evaluated in terms of its relative cost-effectiveness compared to alternative methods of providing the same instruction and practice. The value of computer applications that address issues of higher-order thinking, writing, and general problem-solving skills needs to be similarly evaluated in comparison to traditional alternatives. The value of programming or general computer literacy must be assessed in the context of knowing the future demand for people with an understanding of computers and in knowing the appropriate time and place to provide that expertise for an ever-changing technology.

Basic Skills Learning and Computer-Assisted-Instruction

Elementary and middle schools are investing in computer-assisted-instructional programs of varying technical quality. However, in many cases, they are implementing programs informally and with too few computers, so that the possibility that student achievement might be improved is limited by the manner of implementation. Incentives to invest in existing hardware and software would seem reasonable in pursuit of basic skill objectives, but only **if** computer-based approaches can be assumed to be cost-effective. That is a large "IF."

Some research exists that supports the idea that simple drill-and-practice programs in mathematics and language arts can be cost-effective when systematically applied to a student clientele that is average or below-average in prior achievement. However, most existing research on the effectiveness of computer-assisted-instruction is based on old

equipment, on software not currently in wide use, and on studies that are technically weak. I recently reviewed the evidence on the effectiveness of microcomputer-based instructional programs. Out of 45 studies I could identify, only seven small studies were based on an adequate research design. The seven studies indicated achievement gains generally favorable to computer-based approaches, but the evidence was thinly spread across many grade levels and different subjects.

As I indicated earlier, I have begun my own effort to provide systematic evidence about the effectiveness of these programs. This year, I am conducting a year-long study of computers in middle-grade mathematics classes among 50 pairs of classrooms using commercially available software, with one randomly selected class of each pair using computers while its counterpart is taught using traditional media. In succeeding years, given sufficient support, I expect to conduct similar evaluations of existing practices in writing, science, social studies, and language arts. However, each evaluation will cover only a limited range of computer software and instructional approaches for one school subject over one range of grade levels. Other research like this is necessary if there is to be an empirical basis for encouraging schools to invest in existing hardware and software for subject-matter learning.

My research addresses the question of the effectiveness of current programs for using computers in typical classroom settings. However, the somewhat limited capacity of current computer hardware that schools own places a ceiling of unknown importance on the benefits that can be realized from existing products. Investment in instructional and software designs that maximize didactic and diagnostic capabilities of computer programs -- regardless of whether they can be used on current school-owned hardware -- would seem to have as much benefit in the long run as encouraging further investment in existing equipment and software.

Thinking, Writing, and Problem-Solving Competencies

A second set of instructional goals to which computers are relevant involves the much broader issue of improving students' reasoning, problem-solving, and writing competencies. By means of computers, these competencies are addressed through a variety of types of programs including "simulation" programs, word-processing programs, science lab interfacing programs, intellectually-oriented computer games, and programming languages.

For example, computers could enable students in a social studies or science class to run simulated laboratory experiments or participate in a politico-economic simulation and thus intensively experience a decision-making or inference-requiring situation. Or students may be given a variety of logic puzzles and games, developed as computer programs rather than as physically manipulable materials, in order to exercise their reasoning skills, and hopefully improve their ability to use reasoning in diverse contexts.

Applications of computers which focus on the development of thinking capacities of students are less ingrained in the curriculum of most schools than are applications like computer-assisted-instruction that focus on learning explicit rules and information. Also, we know much less about how to successfully develop students' higher-order thinking and writing capacities than we do about how to teach basic mathematics and English skills or how to teach computer programming skills. Thus, it is not surprising that simulations, problem-solving, computer-based science laboratory experiments, and instruction in editing and revising written text in academic subjects have been much less a part of school computer utilization to date than have basic skills practice and high school programming activities.

Yet some of the more interesting and intellectually provocative instructional software is now being produced to address these "higher thinking skills" aspects of schooling. And computer programs may serve as a wedge through which the curriculum may be reformed so that schools attach greater importance to systematic instruction on

these more difficult-to-define skills and achievements. However, large questions remain about computer-based approaches to higher-order thinking.

Does the software available to schools today (and the instructional plans in which computer activities are imbedded) actually enable students to improve their thinking, writing, and problem-solving capacities or does it merely exercise existing capacities or enable students to learn discrete tasks that do not generalize to other settings? Under what conditions? In this area, the educational value of an instructional approach depends strongly upon the instructional plan for which the software and hardware are mere accompaniments.

And how do we know??? Valid measurement of improvements in thinking, decision-making, and problem-solving and knowing how effective are different instructional approaches are among the most difficult set of educational research tasks we face.

Thus, there is as yet little evidence (although a great deal of hope and optimism) that computer-based approaches will generally improve students' writing, thinking, and problem-solving skills. It is an area of great interest, but great complexity. Support for proposals in this area should demand high levels of sophistication, close attention to instructional processes, and well-designed research and evaluation plans.

Computers as the Subject of Instruction: Programming and "Literacy"

The fact that computers are increasingly permeating both occupational and private realms suggests to many people that most children and adolescents ought to be taught both general and specific skills in writing computer programs and using them so that they can be better prepared for future requirements as producers and consumers. (However, it should be noted that some people have argued that it is not necessary to prepare high school students for technological skills needed in employment settings -- that the skills are so specific and so changing that on-the-job training is the most efficient means to provide this education.)

In any event, buttressed by the fact that secondary school mathematics teachers personally interested in computer programming were the first group of teachers to take aggressive steps to acquire computers for their schools, computer programming, primarily by college preparatory students, has become the dominant use of computers in high schools. Word-processing courses, primarily in business education departments, are the second-most common use in high schools. And courses in "computer literacy," made available on a broader basis throughout middle and high schools, have become increasingly common. For all three subjects, schools are investing in laboratories of microcomputers in order to provide the necessary equipment for entire classrooms of students to be taught at the same time. And the capacity of current machines is certainly sufficient to teach programming and word-processing skills. With schools making these investments on their own, it is not clear that further incentives are necessary.

However, current instructional practice in computer programming, word-processing, and computer literacy is likely to be suffering from insufficiently trained teachers, and, consequently, poor instruction. Teachers responsible for these courses have not had the personal experience in the subject-matter that they have had for other more traditional courses that they teach. Thus, it seems appropriate that most of the support for projects related to adult computing skills be directed towards providing schools with training and increased teacher expertise.

But this leads to a final question -- do school systems or state agencies actually have appropriate expertise in providing this training. Education agencies typically recruit from among the population of practicing teachers and educational administrators. In subject-matters that do not change from generation to generation, this may be advantageous. But in dealing with a subject-area that is almost the embodiment of continuously changing knowledge, can appropriate training (and curriculum development) be developed from within? If districts and states do not start by recruiting people with a broad knowledge about computers to be their own computer experts, funds for school

district teacher training may result in only small improvements in the quality of instruction about computing subject-matter.

Expertise in Evaluating Proposals for Computer Use: Where is it?

The previous paragraph discussed the need for expertise regarding what teachers should know and teach about computer programming, word-processing, and other elements of computer "literacy." But that is not the only manpower issue that can be raised. It is not clear to me that expertise for making decisions about planning and funding appropriate programs for using computers lies within our schools or districts or even within our state agencies. If it did, I don't think we would have seen as much unsystematic acquisition and exploration as we have so far.

It seems more reasonable for the federal government through its Department of Education and the National Science Foundation to retain for itself substantial control over the disbursement of awards. Failing that, the Federal government should be in a position to set clear standards for states to use to make their funding decisions. Also, the Federal government should coordinate and disseminate information about state decisions and awards among the states so that unnecessary duplication of what are essentially experimental projects could be avoided and so that we could maximize what we learn from this investment.

Conclusion

There is no aspect of education for which I am more enthusiastic than that dealing with computers. I have made instructional uses of computers my major occupational activity because I believe that we can use this emerging technology to create instructional materials that will help schools improve students' learning of basic skills, their writing and reasoning, and their understanding of scientific and social worlds.

A bill that represents the major U.S. government commitment to supporting computers and other technology in K-12 education ought to clearly direct the dollars in

ways that would provide the most benefit, in the long-run as well as the short-run interests of American schools. If we thought carefully about which types of investments might best advance particular educational goals, and specified these higher priority directions in the content of the legislation, or otherwise assured that the best possible reasoning and judgment went into making the important financial allocations that the bill provides, I think it would have a stronger impact on education than as drafted here. Nevertheless, I want to commend the Senators responsible for proposing it to the Congress, and I hope I have provided some information and perspectives of some value to you. I would be glad to answer any questions that you may have.

Senator LAUTENBERG. Now we would like to hear from Ms. Dickerson, who is a member of the Hartford Board of Education. We invite you, again, under the same rules—watch the clock—but we're interested in what you have to say. Anything that goes beyond that, of course, we will take as part of the testimony that you are submitting.

Ms. DICKERSON. Senator Lautenberg, I am Thelma Dickerson, a member and past President of the Hartford Board of Education in Hartford, Connecticut.

I appreciate this opportunity to appear before the committee on behalf of the National School Boards Association, the only major education organization representing the local school board members who govern the Nation's 15,000 public school districts. Throughout the Nation, approximately 95,000 of these individuals are Association members.

I would like to highlight some of the major points from my testimony—you have the full text. Hartford, with 27,000 students, is the largest school system in the State of Connecticut. Like other urban school districts throughout the country, we are serving an increasingly diverse student population, not only ethnically diverse but also diverse in terms of their family lifestyles, their expectations and their educational demands and needs.

I really believe that technology can be a resource in addressing the issues that confront educators today. The potential for technology to change dramatically the delivery of education is clearly there, but the possibilities and the realities do not necessarily coincide.

There is a darker side to the potential that those of us in urban areas worry about. In a democracy, education is the great equalizer—it opens opportunities for every child. Technology, however, is expensive. Innovation is expensive.

Studies show that the distribution of computers is very uneven, particularly in the critical earlier years. There is a dramatic difference in student access to computers between affluent and less affluent schools. Students in affluent areas also have far more likelihood of access to computers at home and, yet, some of the most fascinating applications of technology of education have been with students with learning problems and other special needs. It is tough to reconcile these realities.

In September, the high school class of the year 2000 will enter kindergarten. These children will need to understand technology and to appreciate its applications in order to become productive members of the world in which they will live.

I agree with Senator Lautenberg that the United States has no hope of remaining competitive in the world economy unless the use of educational technology becomes a national priority.

I am proud that the National School Boards Association has taken the initiative to establish the Institute for the Transfer of Technology to Education, the only national program specifically designed to bring together school board members, administrators and teachers with technology experts, manufacturers, vendors and trainers. ITTE serves as a clearing house for sharing information about the types and uses of technology in the schools.

I have brought with me copies of the published proceedings of ITTE's technology leadership conference. These conferences were held in November 1986 and April 1987. Looking through the proceedings will give you an idea of some of the technological opportunities available in the schools and some of the issues of concerns to educators.

ITTE has been an ambitious undertaking for NSBA, and a very necessary one. We expect ITTE to grow, but it is only part of what is needed. The National School Boards Association believes a Federal initiative is essential for educational technology. We support the Computer Education Assistance Act of 1987.

There are those who say it doesn't have to cost money to provide quality education. I disagree. To really make a difference in student learning, it can take a major commitment of funds. Even in affluent districts, the percentage of the school budget available for new programming is well below 10 percent.

The Federal seed money that this bill would provide truly can be the impetus for districts to move ahead in computer-assisted education. The allocation formula in the bill would help address the current inequities I have talked about. These inequities can work against not only disadvantaged urban students but also those disadvantaged students in isolated rural settings, as well.

NSBA also supports the bill's provision for local discretion and allocation of funds. Coupled with the bill's planning requirement, this assures that each locality will utilize its funds in a way most appropriate for its students and their particular needs.

One of the goals of our technology network is to encourage districts to undertake thoughtful planning and learn from each other what works. We are pleased that Senator Lautenberg and his colleagues share a concern for planning.

In conclusion, I cannot emphasize strongly enough NSBA's support for this and other Federal initiatives in technology. There is no doubt that there are dramatic changes taking place—dramatic but expensive. Thank you for your attention.

Senator LAUTENBERG. Thank you, Ms. Dickerson.

[The prepared statement of Ms. Dickerson follows:]

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TESTIMONY

on behalf of

THE NATIONAL SCHOOL BOARDS ASSOCIATION

on

S. 838, THE COMPUTER EDUCATION ASSISTANCE ACT OF 1987

before the

SUBCOMMITTEE ON EDUCATION, ARTS AND HUMANITIES

United States Senate
430 Dirksen Senate Office Building

August 4, 1987

Presented by

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Board of Education
Hartford, Connecticut

Also present for NSBA:

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NSBA

I. INTRODUCTION

I am Thelma Dickerson, a member and past president of the Board of Education of Hartford, Connecticut. I am also a member of the board of directors of the Connecticut Association of Boards of Education. I appreciate the opportunity to appear before the Committee on behalf of the National School Boards Association. The National School Boards Association is the only major education organization representing the local school board members who govern the nation's 15,000 public school districts. Throughout the nation, approximately 95,000 of these individuals are Association members. These people, in turn, are responsible for the education of more than 95 percent of the nation's public school children. NSBA's primary mission is the advancement of education through the unique American tradition of local citizen control of -- and accountability for -- the nation's public schools.

II. TODAY'S SCHOOLS AND TECHNOLOGY

Hartford, with 27,000 students, is the largest school system in the state of Connecticut. Like other urban school districts throughout the country, we are serving an increasingly diverse student population -- not only ethnically diverse, but also diverse in terms of their family lifestyles, their expectations, and their educational demands and needs. We have extremely capable students who need the challenge of a very advanced curriculum, and we

have students from very disadvantaged homes -- and sometimes those are the same youngsters. Often, we must provide educational opportunity for our students without the traditional support structure provided by the home.

These are very interesting -- and complicated -- times to be in education. In Hartford and throughout the country we are learning new ways to deliver early childhood education. Many school districts are moving toward pre-kindergarten programming to help young children, particularly those from disadvantaged homes, be ready to learn. The first generation of handicapped children to benefit from the mandates of Public Law 94-142 are growing up. More and more districts have more and more children coming to school with limited English proficiency. Some districts have massive dropout problems that they are working to address. And all districts face the challenges of teenage pregnancy, substance abuse, underachievers, and decreased parental involvement in education.

III. THE POSSIBILITIES AND THE REALITY

I really believe technology can be a resource in addressing these issues. Computer-assisted instruction is changing special education, vocational education, language arts instruction, and, of course, mathematics and science education.

Computers are only one part of a vast array of technological opportunities now coming of age. The introduction of computers seems to have been the catalyst for opening up new uses of other technology. Educational television, for example, is suddenly much, much more than that television set

in the corner of the classroom collecting dust. It is a vital link from the classroom to the outside world. The possibilities of interactive television are incredible. Not only can students study with a teacher hundreds or thousands of miles away through a satellite hook-up. They can even sit in their classrooms and take a "field trip" inside a volcano, talking to a scientist at the volcano sight through two-way television.

The potential for technology to change dramatically the delivery of education is clearly there. But there is another darker side of the potential that those of us in urban areas worry about. In a democracy, education is the great equalizer -- it opens opportunities for every child. Technology, however, is expensive. Innovation is expensive. If access to technology depends on the ability of each district to afford the expensive hardware, software, and human resources necessary, it can mean that the disparity between urban districts -- with already severely strained budgets and often with many more complex problems than more affluent suburban districts -- may threaten the very concept of education as the great equalizer.

A few simple statistics demonstrate my point. Today, virtually all American schools have at least some instructional computers, up from only 18% as recently as 1981. The national average of students to computers is now about 37 to 1, and computers will undoubtedly continue to proliferate. But the distribution of computers is very uneven, particularly in the critical earlier years. Even within the same district, elementary and middle schools in low socioeconomic areas have about twice as many students per computer as schools in affluent areas, resulting in a dramatic difference in student access, particularly when we know that where there is a limited number of computers

their use is often restricted to only the most academically able students. The fact that one-half of the homes in the United States will have computers by 1990 only reinforces my concern, since the students in affluent areas will not only have greater access to computers during the school day but also far more likelihood of access at home. And yet some of the most fascinating applications of technology to education have been with students with learning problems and other special needs. It is tough to reconcile these realities.

Several federal education programs offer some support for the use of technology. Existing categorical programs such as Chapter 1, the Education of the Handicapped Act, and the Bilingual Education Act enable districts to use technology for targeted populations -- to a limited extent. Chapter 2 and the Education for Economic Security Act, which provides funds for math and science programming, authorize the use of technology. The Vocational Education Act can also serve as a funding source for education technology. But in each of these cases, technology is an afterthought at best. We cannot look to these existing education programs for the bold initiative needed.

In September, the high school class of the year 2000 will enter kindergarten. These children will need to understand technology and to appreciate its applications in order to become productive members of the world in which they will live. I agree with Senator Lautenberg that the United States has no hope of remaining competitive in the world economy unless the use of educational technology becomes a national priority.

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IV. THE INSTITUTE FOR THE TRANSFER OF TECHNOLOGY TO EDUCATION

I am proud that the National School Boards Association has taken the initiative to establish the Institute for the Transfer of Technology to Education, the only national program specifically designed to link up education policy-makers with technological expertise. ITTE, established in 1985 by NSBA and its federation of state school boards associations, serves as a clearinghouse for sharing information about the types and uses of technology in the schools through written materials, networking, and sponsorship of conferences to discuss technology and its applications, bringing together school board members, administrators, and teachers with technology experts, manufacturers, vendors, and trainers. ITTE serves local school districts by highlighting opportunities, offering options, initiating and monitoring pilot projects, and providing research and evaluation. I have brought with me copies of the published proceedings of ITTE's Technology Leadership Conferences in November 1986 and April 1987. Looking through the proceedings will give you an idea of some of the technology opportunities available in the schools and some of the issues of concern to educators.

V. THE NEED FOR A FEDERAL DIMENSION: SUPPORT OF S. 838

ITTE has been an ambitious undertaking for NSBA -- and a very necessary one. We expect ITTE to grow. But it is only one part of what is needed. The National School Boards Association believes a federal initiative is essential for educational technology. We support the Computer Education Assistance Act of 1987.

There are those who say it doesn't have to cost money to provide quality education. I disagree. To really make a difference in student learning, it can take a major commitment of funds. For example, Indian Springs, Illinois, a low- to middle-income Chicago suburb, with 2300 students, has received $850,000 since 1979 from IBM and state and federal education departments to install computers for administrative and instructional use. Test scores are going up in Indian Springs, but the district could not have made this type of financial commitment on its own. A comparable commitment -- to try something new -- is beyond the capability of the tax base in many localities. Even in affluent districts, the percentage of the school budget available for new programming is well below 10%. The federal seed money that this bill would provide truly can provide the impetus for districts to move into computer-assisted education.

Because the allocation of funds would be based equally on student population and the Chapter 1 formula, and because each state is required to assure that at least half the funds are used to serve Chapter 1 eligible children, the bill would help address the current inequities I have talked about. These inequities can work against not only disadvantaged urban students but also those disadvantaged students in isolated rural settings as well.

NSBA also supports the bill's provision for local discretion in allocation of funds for hardware, software, or the critical element of inservice training for teachers. Coupled with the bill's planning requirement, this assures that each locality will utilize its funds in a way most appropriate for its students and their particular needs.

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At a meeting of NSBA's ITTE network in June, a key message was the need for wise selection and use of technology. In fact, the need for orderly planning for the incorporation of technology into education was one of the reasons NSBA established ITTE, and we are pleased that Senator Lautenberg and his colleagues share a concern for this need. One of the goals of our technology network is to encourage districts to undertake thoughtful planning and learn from each other what works -- to avoid haphazard acquisition of hardware and software that may not meet the district's educational objectives. NSBA supports the requirement that districts prepare plans for use of federal funds in development of computer resources, provided neither the state nor the federal government has discretion to review locally-developed plans.

An exciting element of the bill is availability of computers for after school and vacation time use. The opportunity for students, teachers, and parents to have greater access to this new technology whether or not they can afford personal ownership of a computer is important.

In the fast-changing world of computers, teacher training is essential. We are moving from a time when certain "computer whiz" types trained themselves to be experts into an era where all teachers will need an in-depth appreciation of the relationship of computers to their field of expertise. S. 838 wisely includes a teacher training component.

VI. CONCLUSION

In conclusion, I cannot emphasize strongly enough NSBA's support for this and other federal initiatives in technology.

We know there are a lot of computers in schools. And we know there are inequities, with disadvantaged students having significantly less access to computers than more affluent students. And yet we also know that computer-assisted education can be a significant factor in helping disadvantaged and other at-risk students achieve their potential.

We also know that sensible planning and sensitive teacher training are essential if computers are to be truly incorporated into the educational environment of our country.

These are some of the reasons NSBA established the Institute for the Transfer of Technology to Education. And, we believe, these are some of the reasons the Institute has received such a resounding welcome both from the technology community and from educators. These are also some of the reasons NSBA supports the Computer Education Assistant Act.

There is no doubt that there are dramatic changes taking place -- dramatic but expensive. Local school boards welcome your support as we move into the computer age -- and we look forward to working with you to plan for the future of the United States.

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Senator LAUTENBERG. Now, we will hear from Ms. Monahan—around here we usually say "Moynihan," and Pat Moynihan gets upset when people call him "Monahan." I think we're right, are we not, Marilyn, in that it's "Monahan."

Ms. MONAHAN. That's right.

Senator LAUTENBERG. We invite you give your testimony, recognizing that even though you're last, that we will still be merciless in the way we administer the clock.

Ms. MONAHAN. Thank you, Senator. My name is Marilyn Monahan. I am President of the National Education Association in the State of New Hampshire. On behalf of the 1.8 million member National Education Association, I appreciate this opportunity to speak on the use of computers in both the public elementary and secondary schools.

NEA strongly supports Federal legislation to help local school districts purchase computer hardware and software and train professional educators. In addition, we believe that planning—planning which involved classroom teachers—is essential to the effective use of computers in our schools. The Computer Education Assistance Act of 1987 would make an enormous contribution to meeting the needs of America's public schools.

Advances are being made almost daily in the development of computer hardware, software and applications. We must now help our students develop the skills to capitalize on these advances.

In this field, more than any other, America's teachers and students are learning from each other. There is no question that computers can be effective teaching and learning tools. In fact, the more opportunities teachers have to use computers, the more applications they find.

But as all the testimony today has indicated, there are wide disparities in access to computers. The ability of a school district to purchase and maintain computers and to provide training for teachers using them depends, to a large extent, on the commitment and the resources of that individual community.

Obstacles to educational equity also exist within school districts and within individual schools. Almost all school districts have some computers for student use, but the ratio of students to computers is still too high to allow most students adequate time on tasks. These obstacles are not just limited to access, but they are truly limits to the imagination of America's schoolchildren.

States, local school districts and public school patrons have made great sacrifices to make computers available to all students, but these efforts alone cannot fully meet existing needs. The only way to ensure equity of opportunity for all students is to provide Federal assistance to local school districts to purchase computer equipment and software.

Student access to computers is also limited by the interest and experience of teachers. NEA has always held that there must be a qualified teacher in every classroom. And yet, if computer literacy is to be a component skill of a qualified teacher in the 1980's and beyond, then local school districts, with the help of the state and Federal governments must help teachers develop that computer literacy.

Some school districts have systematic plans for helping faculty members develop computer skills, but many more do not. Those teachers who have moved most quickly are those who have devoted their own time and their own expense to the development of computer literacy.

There is a growing need for specialized computer-training opportunities geared toward educational applications. We believe that these should be made a part of a local school district's in-service training program, and we support direct Federal assistance to help train classroom users of computer technology.

Let me briefly highlight three other points from the written statement that we have already submitted. First, the pioneers of computer-based education have made tremendous contributions in the area of curriculum development by developing networks for sharing educational software and materials. But this approach has depended too heavily on teachers using their own funds to purchase software and materials. In addition, local school districts clearly need the means to establish better systems for evaluating commercially-developed software.

Second, computers in the schools must be used in ways that contribute to the national goal of educational excellence. Toward that end, teachers should be involved at every level in the planning, implementation and evaluation of a school's educational program. Nowhere is this more important than in computer-based education.

Third, whatever technological advances we may make, whether in computers, video equipment or some other development just over the horizon, it should be recognized that instructional technology is a means of supporting, rather than supplanting, the classroom teacher.

NEA has testified before Congress a number of times on computers in the schools and the need for Federal resources to help local school districts use computers effectively. We are pleased to see legislation introduced that incorporates so many of our recommendations.

The Computer Education Assistance Act of 1987 would authorize more than $170 million in fiscal year 1988 to expand the use of computers in the public schools. Today, we ask you to help put the information that this bill would cause into the hands and minds of America's public schoolchildren.

Thank you, Senator.

Senator LAUTENBERG. Thank you very much.

[The prepared statement of Ms. Monahan follows:]

LEGISLATIVE INFORMATION

TESTIMONY

OF THE

NATIONAL EDUCATION ASSOCIATION

ON THE

COMPUTER EDUCATION ASSISTANCE ACT OF 1987

BEFORE THE

SUBCOMMITTEE ON

EDUCATION, ARTS AND HUMANITIES

OF THE

COMMITTEE ON LABOR AND HUMAN RESOURCES

U.S. SENATE

PRESENTED BY

MARILYN MONAHAN

PRESIDENT, NEA-NEW HAMPSHIRE

AUGUST 4, 1987

MARY HATWOOD FUTRELL, President • KEITH GEIGER, Vice President • ROXANNE E. BRADSHAW, Secretary-Treasurer
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Mr. Chairman and Members of the Subcommittee:

I am Marilyn Monahan, president of NEA-Hampshire. On behalf of the 1.8 million-member National Education Association, we appreciate the opportunity to speak on an issue of vital national concern -- the use of computers in public elementary and secondary schools.

NEA strongly supports the enactment of federal legislation that would provide significant assistance to local school districts for the purchase of computer hardware and software, as well as resources to provide training for professional educators. In addition, we believe that developing a plan for the use of computers in the schools is essential to the effective use of computers as an educational tool, and that such planning must involve classroom teachers at every stage.

The Computer Education Assistance Act of 1987 is a comprehensive measure which would make an enormous contribution to meeting the needs of America's public schools. We are particularly pleased that the authors of S. 838 recognize that school districts in disadvantaged areas have unique needs and that providing equipment alone is not sufficient to assure that computers are used in ways that will improve educational practices in the public schools.

We agree with Senator Lautenberg that computer education is not a substitute for the three R's, but rather a means of achieving the academic goals our schools and our society demand. And we concur that a federal investment of this kind will pay for itself many times over.

Computers in the Schools

A little more more than 35 years ago, the use of computers moved beyond the domain of a small coterie of academics. The development of UNIVAC opened

the doors for the application of computers in government, business, and industry. UNIVAC opened the doors, that is, to anyone who had the money and the enormous space required to house that early computer. Today, computers touch nearly every aspect of our lives, from the most complex problems in theoretical physics to more mundane matters, such as tallying family budgets.

The widespread use of computers has been instrumental in dramatic breakthroughs in virtually every field of human endeavor: engineering, biology, physical and social sciences, business and industry, fine arts, law enforcement, and even law-making. I would be very surprised if the Members of this Subcommittee did not have computers in your offices here on Capitol Hill and back in your state offices, and I venture to guess that many of you have computers at home, as well.

Computers are, in fact, so prevalent that we tend to take them for granted. And yet, while we marvel at the astounding achievements of computer technology, we tend to forget that a computer is, after all, only a machine. Behind every successful computer is a human operator.

We are here today to draw attention to that human element. Advances are being made almost daily in computer hardware, software, and applications, and it is essential that we help the coming generation develop the skills to capitalize on these advances. Fortunately, today's computers can -- at the same time -- be used to help individuals develop these and other skills.

Since the technological developments that produced the microcomputer boom have occurred only over the past decade, it can truly be said that teachers are entering the computer age at the same time as their students. In this field, more than any other, America's teachers and students are learning from each other.

Access to Equipment

There is no question that -- under the right conditions -- computers can be an effective teaching and learning tool. Computers can vastly expand students' access to information. Computers can aid comprehension by presenting abstract concepts graphically. Computers can be used for practice and drill in vocabulary, mathematics, and other subjects. More importantly, computers can inspire students to manipulate information in ways that challenge them to analyze, synthesize, and solve problems. In fact, the more opportunities teachers have to use computers, the more educational applications they find for them.

But, sadly, like so many other aspects of educational opportunity, there have been wide disparities in access to computers from school district to school district and, within school districts, from program to program.

The ability of a school district to purchase and maintain computers, and to provide adequate training and experience for teachers using them in the schools, depends to a large extent on the commitment and resources of the community. As a result, students in low-income areas are at an extreme disadvantage for a number of reasons. School districts with relatively high per pupil expenditures are far more likely to have the resources to purchase computer equipment from district funds. They are more likely to have computers donated by school patrons. And they can better afford to maintain the software, materials, and peripherals -- as well as the inservice training and curriculum development -- to ensure effective use of computers.

At the same time, obstacles to educational equity exist within school districts and within individual schools. We have moved away to some degree from the days when computers in the schools were used only by students whose primary interests were math and science. Today's teachers, many of whom are

truly pioneers in computer assisted instruction, are finding ways to use computers to challenge students in such subjects as writing, social studies, and the creative arts. But the limited availability of computers has, in many cases, restricted the scope of their use to math and science fields or to classes where the curriculum objective is mastery of computer skills.

The most recent nationwide survey conducted by NEA showed that while almost all school districts have some computers for student use, the ratio of students to computers is still too high to allow most students adequate time on task.

These obstacles are are not just limits to access; they are limits to the imagination of America's schoolchildren.

States, local school districts, and public school patrons have made considerable sacrifices in an effort to make computers available to all students. But these efforts alone cannot fully meet the needs. The only way to ensure that the coming generation is fully prepared to meet the challenges of the future is through a national investment. NEA believes the federal government should provide direct assistance to local school districts for acquisition of computer equipment and software in a way that achieves equity of opportunity for America's public school students.

The Training Needs of Educators

Limits to student access to computers are also generated by the interests and experience of teachers. To a large extent, today's experts on the use of computers in the classroom are those teachers who have made the personal decision to devote their own time and expense to the development of computer literacy. In the absence of broader access to learning opportunities, or opportunities for teachers to share effective lesson plans

and teaching methods, the use of computers for a broad range of academic disciplines and grade levels has been catch-as-catch-can.

NEA has always held that there must be a qualified teacher in every classroom. If computer literacy is to be a component skill of a qualified teacher in the 1980s and beyond, and we believe it is, then local school districts -- with the help of state and federal governments -- must provide more systematic means of helping teachers develop computer literacy.

Teacher training and curriculum development take many different forms across the country. There are many school districts which have established systematic plans for helping faculty members develop computer skills. But there are many more which, because of limited resources, do not. In between these extremes there are school districts which do encourage teachers to learn how to use computers on their own time by providing funds for educational expenses. Many other teachers have used their own funds to take courses. Those who have moved most quickly in developing computer skills are those who have access to their own computers at home.

One critical disadvantage of relying on general purpose computer skills classes is that they tend to be geared toward computer applications in the business world or for personal use. There is a growing need for specialized computer training opportunities geared toward educational applications. We believe that these can best be conducted as a part of a local school district's inservice training program. NEA supports direct federal assistance to local school districts for the training of classroom users of computer technology.

There exists among the ranks of America's teachers -- as among the general population -- a degree of computerphobia. But it has been shown time and again that this fear can be easily overcome when people have

opportunities to practice on and become familiar with computers. It is not enough to put people through a course of training for several hours or even for several days if they do not have a chance to reinforce those concepts through practical application.

Appropriate Software

The situation in the area of computer curricula and curriculum development is much the same as that for teacher training. There are school districts that have systematic plans for developing curricula for computer-based education and that provide resources and opportunties for teachers and curriculum specialists to develop programs and materials to facilitate effective use of computers in the schools. But, again, too many are at the other end of the spectrum where teachers and other professional educators are left to their own devices.

In this environment, the pioneers of computer-based education have again made tremendous contributions. Across the country there are many networks for sharing educational software and materials on a districtwide, statewide, or nationwide basis. But again, the success of this approach has depended too heavily on individual teachers using their own funds to purchase software and materials.

There is another force at work over which the schools at present have little control. There remains a shortage of quality, commercially available software appropriate for the schools. A number of companies have entered the market of educational software, but the quality of these products is uneven, and many districts have not been able to obtain the advice they need to make software purchases that are appropriate to their needs. Too often, computer software sits unused because it did not meet the schools' educational needs.

Local school districts clearly need the means and the resources to establish better systems for evaluating software.

Planning

Local school districts have a responsibilty to ensure that computers in the schools are used in ways that make a significant contribution to the national drive for educational excellence. If we are to make this investment in computers, we must ensure that school districts avoid 1) the underutilization of computers, such as using them for drill and practice alone, 2) the inappropriate use of computers, such as using them for games alone, or 3) leaving them idle.

NEA believes that teachers should be involved at every level in the planning, implementation, and evaluation of a school's educational program. Nowhere is this more important than in an area such as computer-based education, where students, teachers, administrators, and the community at large are all working to come to grips with emerging innovations in the technology, ancillary services, software, and materials.

We believe that there should be at the outset an understanding among all concerned parties that computers should be used as a teaching tool and cannot in any sense serve as a replacement for teachers. No matter what technological advances we may make as a society, qualified teachers remain essential to the teaching-learning process. Whether it is computers, video equipment, or some other new development just over the horizon, instructional technology should be used to support rather than supplant the classroom teacher.

Conclusion

NEA has testified before Congress a number of times, relating our concerns about the use of computers in the schools and the need for federal resources to help local school districts obtain adequate equipment and software and to help teachers acquire the skills necessary to use computers effectively. We are pleased to see legislation introduced that incorporates so many of our recommendations.

The Computer Education Assistance Act of 1987, S. 838, authored by Sen. Lautenberg and others, would authorize $150 million in Fiscal Year 1988, providing a significant federal contribution to expand the use of computers in the public schools. In particular, we support the emphasis on areas of need through allocation of half of the funds according to the formulas of Chapter 1 of the Education Consolidation and Improvement Act of 1981. We commend the sponsors of S. 838 for including provisions that require planning at the state and local level and that would provide grants to ensure that school staffs have opportunities to develop the skills necessary to use this equipment effectively.

We have come a long way from the days when a UNIVAC-era computer would just about fill a Senate Committee hearing room to the present time when a person can access a computer with UNIVAC-sized memory with a lap top unit. In a very literal way, we have taken information out of the closet and put it into the hands of millions of Americans. Today we ask that you support this effort to put that information into the hands and the minds of America's public school students.

Thank you.

Senator LAUTENBERG. We thank you very much, not only for being with us and not only for your excellent testimony, but for your patience in terms of waiting for your turn, as we say, at bat. It was very helpful. The ideas that I gleaned as we discussed the testimony these last minutes are very helpful, I mean for the perspective on education and business.

I come from the industrial side of things, the service industry, the computer industry, and we sure don't have our senior executives typing, making copies, et cetera. What we do is we use them for their best skills, and we get very good productivity that way, so we ought to in schools.

I'm sure, Ms. Monahan, you would agree that if we can cut down the ordinary clerical requirements that teachers have and permit them to get more immersed in programs like this, the better off the students are going to be. So with that, we will call this subcommittee hearing, Subcommittee on Education, Arts and Humanities, to an end. And we thank all of you for joining us today. Thank you very much.

[Additional material submitted for the record follows:]

The
Hartford
Graduate
Center

Dear Hartford Graduate Center,

Juan and I like coming to Computer Camp. One thing we like about it is the special kind of teachers that you select for the camp. To come here is a privilege. When I grow up I would like to work here. We appreciate using the IBM Personal Computer.

We've been coming here since we were in third grade. Every year we come it gets better and better. We like using the new Logowriter.

We hope this program never ends. It is the best one around. Working on computers is the summer is better than playing baseball.

275 Windsor Street, Hartford, Connecticut 06120 — (203) 548-2400

The
Hartford
Graduate
Center

Thank You for The Wonderfull

Year's With You.

Sincerly.

JUAN DIAZ

AND

CARLOS IRIZ

275 Windsor Street, Hartford, Connecticut 06120 — (203) 548-2400

The
Hartford
Graduate
Center

The Guy Dressed In Black

One morning Carlos and Juan were walking to the Hartford Graduate Center. They went into the store to buy some candy, when suddenly they saw a guy dressed in black clothing.

The two boys came out of the store, and noticed that the man was following them. They got frightened. They started to walk real fast when they came a light where they had to stop.

They had two choices. They could take a shortcut or wait for the light to change. What should they do?

1. Type SHORT if you want them to take the shortcut.

2. Type LIGHT if you want them to wait for the light.

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The
Hartford
Graduate
Center

SHORTCUT

They took the shortcut and ran as fast as they could. They went through someones backyard. Then suddenly the boys saw a big dog. The dog started biting at the boys shoelaces. The owner came outside. The dog let go of the shoelaces.

Juan and Carlos were very nervous and without even thinking of it jumped the fence. They reached the Hartford Graduate Center very tired but relieved. They noticed that they were late, so the boys had to go around the building. They went in and sat down. After sitting for awhile catching there breath they suddenly turned around and saw the man dressed in black. It was' not a stranger at all. It was actually one of the teachers at the Hartford Graduate Center.

THE END

275 Windsor Street, Hartford, Connecticut 06120 — (203) 548-2400

The
Hartford
Graduate
Center

LIGHT

The light turned green. The boys crossed the street. He kept following them. They passed by Newberries and he was still following them. They passed by Rite Aid and he was still following them. They kept walking. Then they passed G.FOX andhe was still following them. They walked behind Barnard Brown. They saw the Computer Camp group. They ran to the line. They went into the Graduate Center and sat down. The man dressed in black was one of our teachers at Computer Camp named Mr.Mahoney. Mr.Bernhard introduced us to him. We were very happy to meet him.

THE END

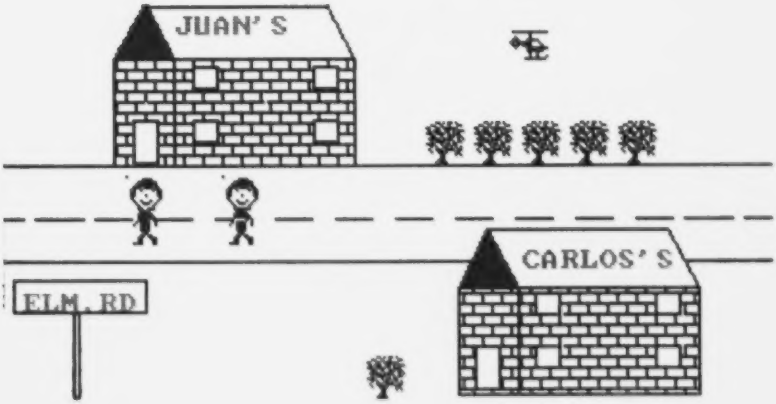
By Carlos Toro

AND

275 Windsor Street, Hartford, Connecticut 06120 — (203) 548-2400

The
Hartford
Graduate
Center

275 Windsor Street, Hartford, Connecticut 06120 — (203) 548-2400


JUAN' S
CARLOS' S
ELM. RD

Did you ever see time fly?
Here is what it looks like.

Senator LAUTENBERG. The hearing stands adjourned.

[Whereupon, at 1 p.m., the subcommittee adjourned subject to the call of the Chair.]

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